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WORKSHOP

No 20

THE PRACTICAL HOBBY MAGAZINE



HOME
SWEET
HOME!

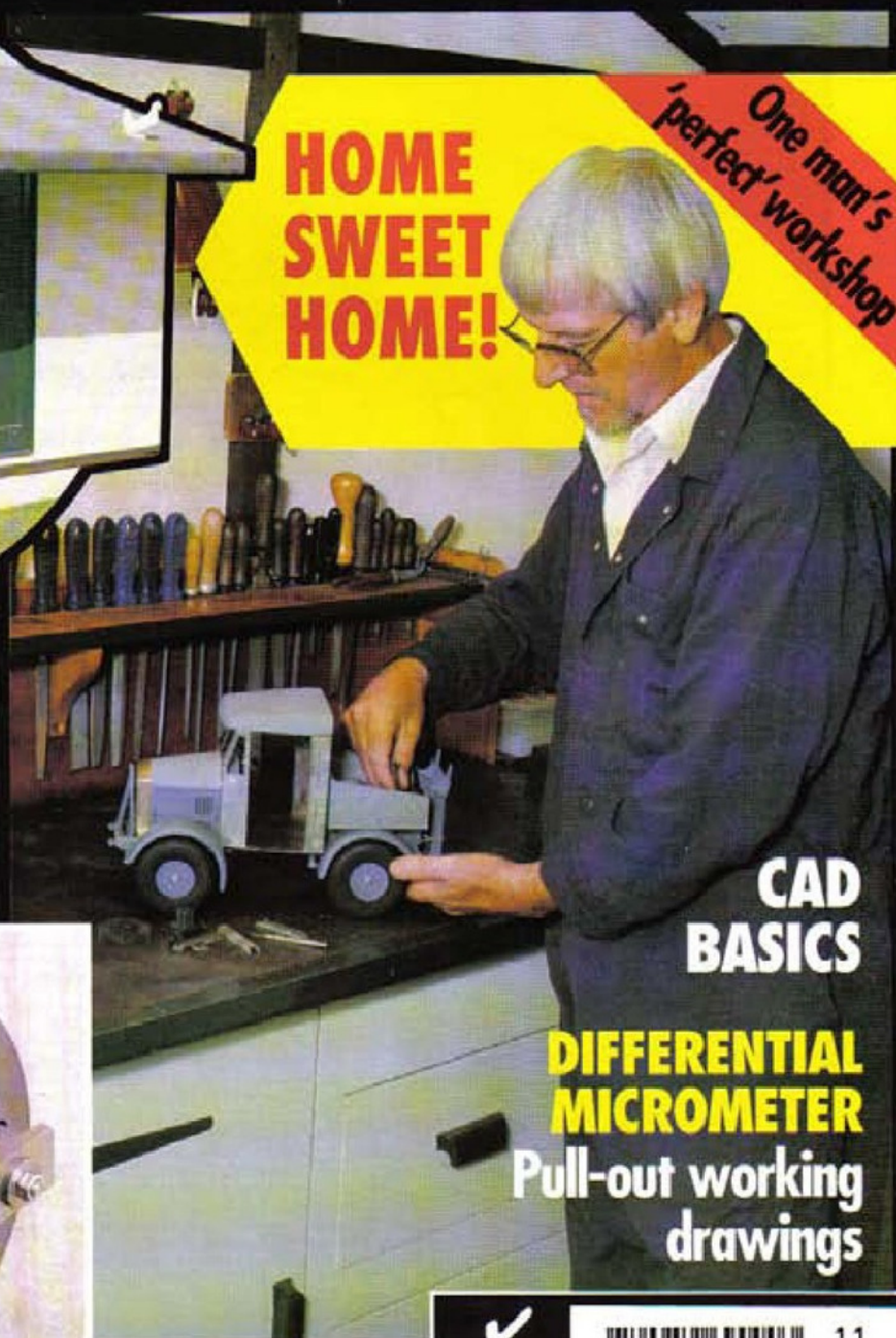
One man's
'perfect' workshop

YORTEK AWARDS

Young designer honoured

FERROUS MATERIALS

A practical guide

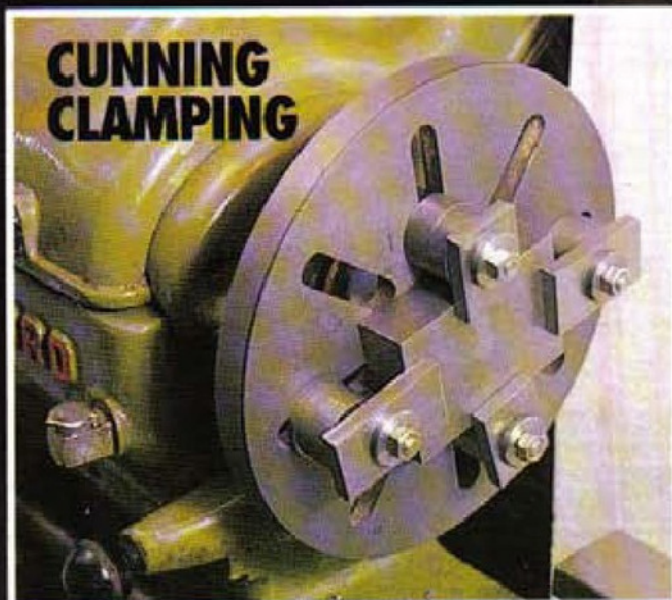


**CAD
BASICS**

**DIFFERENTIAL
MICROMETER**

Pull-out working
drawings

**CUNNING
CLAMPING**



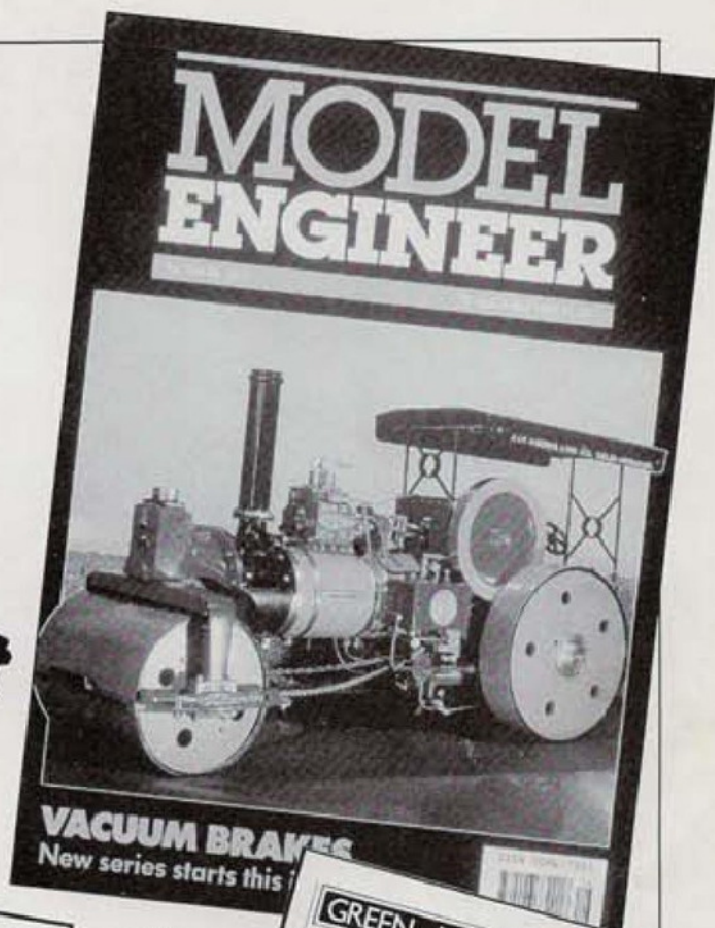

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11

**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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Editor: Harold Hall

Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST, tel. 0442 66551

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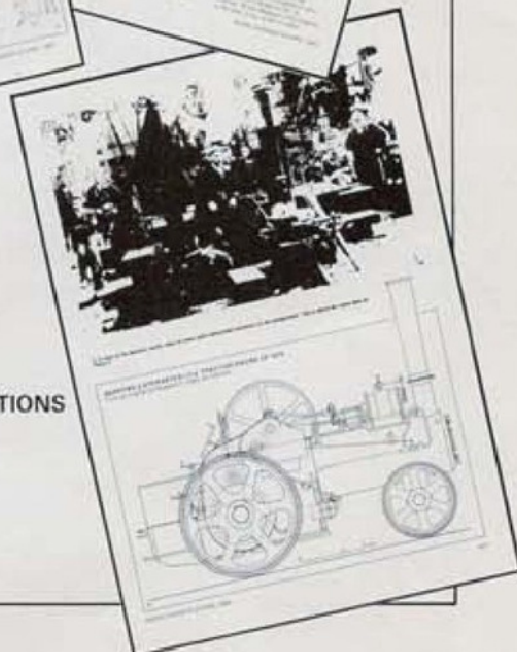
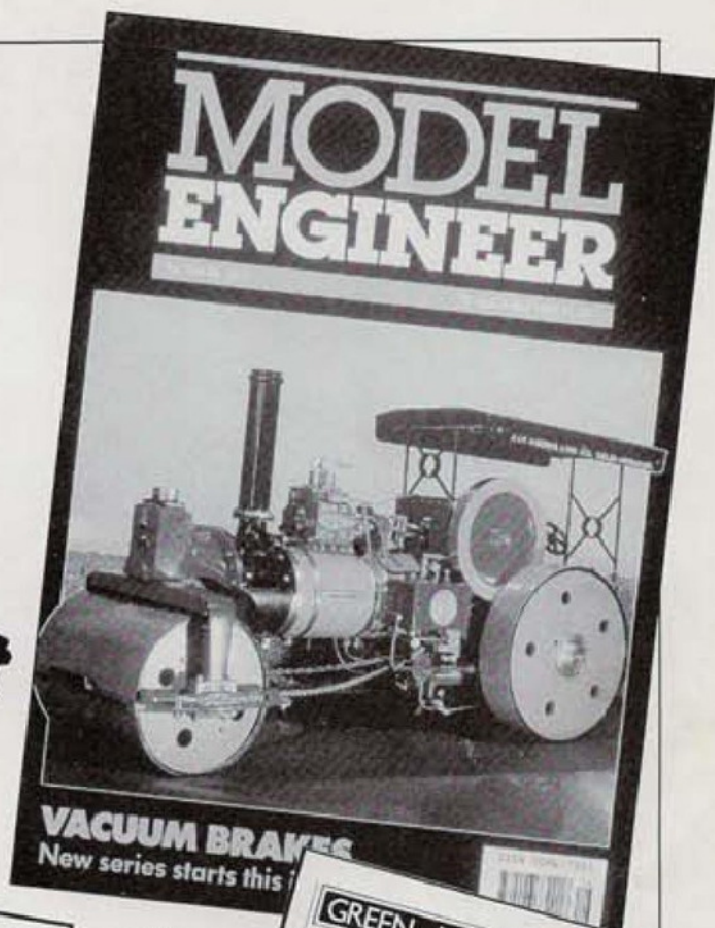
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Readers views and ideas


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...every fortnight



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Harold Hall

ON THE EDITOR'S BENCH

Model Engineer Exhibition - M.E.W. display

May I, through this column make one final plea for you to consider displaying your work at the forthcoming Model Engineer and Modelling Exhibition at Olympia. For the first time an M.E.W. display is being arranged, as part of the Loan Section. This is non competitive; it is anticipated that many items displayed will not be made to the highly finished standard sometimes associated with the competition section. However, should you have some item made to such a standard, why not enter it in the appropriate competition class? These are open to all, not limited to readers of *Model Engineer*.

It is anticipated that items for this section will be largely of workshop equipment, but is in no way limited to such. So, if you have made any item of an engineering nature in your workshop, please feel free to enter it, it will be more than welcome. All entries will receive a certificate of acceptance and entrants will of course get free tickets etc.

A few readers have written stating a desire to display some item but see problems getting the item to the exhibition. There has been for some years, for those unable to deliver and collect exhibits themselves, an arrangement to collect exhibits from various locations around the country, just prior to the exhibition and return them immediately after. This was expanded considerably last year, with many more people being involved. As a result, collections were made only a day or two before the exhibition, exhibits were taken direct to the exhibition hall, they were similarly returned very soon after the close. The facility will be further enlarged this year for an even better service.

Hopefully, the M.E.W. display will become a permanent feature of the exhibition, may I request that you consider sending in an exhibit, thus helping to get the idea of a good start. I propose to report the display in M.E.W. and endeavour to make mention of all items exhibited, with photographs of some of them.

For details of how to enter, and the pick up service locations etc., write to Argus Specialist Exhibitions, Argus House, Boundary Way, Hemel Hempstead, Herts, HP2 7ST. Tel. 0442 66551. Fax. 0442 66998. Please mark your return form "M.E.W. display" if this is where you wish it to be exhibited. I would also suggest that you return to issue 19 and re-read page 51.

Tailstock turrets

In connection with a future article, I need some photographs of the Sparey six way tailstock turret, as detailed on Argus Plan MM127. Has any reader made this and

would be prepared to supply me with a couple of photographs? If so, please write to me first before taking any pictures. Similarly, photographs of the Exactus six way turret, as shown on Argus Plan WE6, would be useful. I could arrange to take the photographs if within say 50 miles of Hemel Hempstead.

CAD

In this issue we start a two part series on CAD, (computer aided draughting) which was first mentioned in *On The Editor's Bench* way back in June/July 92 issue. This gives an indication of how long it can sometimes take to bring an idea into print.

Whilst the article is in two parts, these are published with quite different intentions. The first is an attempt to illustrate to the total readership a brief indication of how a typical CAD system performs its major tasks. It is therefore intended as just interesting reading for the majority. On the other hand, for a few, the article may establish a desire to consider further the possibility of setting up one's own CAD system. The second part of the series is aimed at just those readers, and assumes that these have no computer experience, or at best, only limited computer knowledge gained through the use of perhaps a simple word processor.

The reader survey

The results of the recent reader survey have now been analysed and make interesting reading. It is encouraging to find two things; a substantial increase in the number of forms returned, and an increase in the level of reader satisfaction with the magazine. May I express my thanks to all those readers (700 + to date) who have returned forms, and confirm that I have looked at each one. I may comment on some of the more individual statements by readers, from time to time in this column, but some indication of the overall view is published elsewhere in this issue.

M.E.W. index

I have received contradictory views on the subject of the M.E.W. index. One reader expressed his view that the approach was very beneficial, whilst two felt the method of just indexing by article title, as done in *Model Engineer*, should be the one adopted. The index is prepared using a very simple computer database programme, with the idea that it is a continually expanding index to cover all issues to date. Even now, with only twenty issues, the attempt to remember every article title is a non starter as far as I am

concerned. What will it be like when M.E.W. reaches a ripe old age like M.E?

The system as presently published does, I admit, need some tidying up. I do however, anticipate that periodically the complete index will be offered to readers in some form or other. This could even be, in addition to paper copies for those who want it that way, in the form of a computer disc. I would like very much to learn of readers views on the subject, in particular, what method of indexing is preferred.

Articles received

In the early days of M.E.W. magazine both Stan Bray and myself found it somewhat difficult to fill the magazine with suitable articles. Fortunately this situation has improved and there is now sufficient in reserve for a few issues. As a result, some authors contributions have been held for quite a few issues in the interest of producing a balanced magazine.

I am making these comments for two reasons; firstly I wish to let these authors know that all submissions have been retained (just one, maybe two, were passed to *Model Engineer*) and with a very few exceptions will eventually be used. I will attempt to contact the authors regarding these exceptions in the near future.

Secondly, despite the articles in reserve, there has been a very noticeable decline in the number received in recent months; should this trend continue, articles will again not keep up with requirements. Therefore, I would like to request that should you have an item that you have made, or skill that you possess, and would make an interesting article, you consider offering it to the magazine.

Please, first write and make your offer known to me, this may prevent you from spending valuable time on something I cannot accept. Also if you have never written for M.E.W. previously, I suggest you request a copy of our notes for authors. Some authors have written for the magazine not knowing that a fee is paid; a few pages will certainly buy you a new three jaw chuck, whilst a longer article spanning two or three issues could even buy a small lathe.

Telephone numbers

May I once again make a request for readers to include their telephone numbers on any letters sent to me, this may enable me to reply more rapidly. If you are only available in the evenings or on Saturdays this is O.K., I am quite happy to phone at such times.

Back issues

I am still getting requests from time to time regarding back issues particularly Issue 2, which is no longer available. I do get requests for issues that are still available. For copies of recent issues (last 6) contact Redhill; however some earlier issues are available, albeit now in very small quantities in some copies, from Copy Sales at Hemel Hempstead.

Copies not available on the latest list are Nos. 2, 5, 6 and 8. In view of the small number of copies available of some earlier issues, please do phone first. If all else fails, I understand that TEE Publishing (tel. 0455 6167173), who sell secondhand copies, have started a waiting list.



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Reproduced by courtesy of Autodesk - Sketch 1

CAD CAPABILITIES

PART 1

With the continual increase in the numbers of computers in the home (see report on Reader Survey) the possibility of its use as a drawing facility for the home workshop is fast becoming a practical proposition. In this the first of two parts, the abilities of Computer Aided Draughting (CAD) in general is covered, it should prove interesting reading even for those who have no intention of going in this direction. Part II will review a few packages and chooses three, ranging in price from £50.00 to £120.00 which are ideal to back up the home machine shop.

Most readers will be aware of the gradual entry of the personal computer to the domestic scene. It is likely to have been acquired for one or more of the three most usual purposes:

- 1) Games,
- 2) Practical uses, (word processing or as an educational aid.
- 3) A hobby outlet for the computer enthusiast.

Already in the relatively short life of M.E.W. a few articles detailing computer programs have appeared. These most definitely fall into category 3 above, i.e. written for the computer enthusiast. It is most definitely not intended that this article should fall into that category. The intention is to explore the use of a Computer Aided Draughting (CAD) system as a practical aid to workshop activity.

For some, the computer can become as much a consuming passion, as their home workshop. Such people will continually be searching for the most powerful in both software and hardware for their computer. Typical of this in the CAD world, would be the desire to graduate from 2D to 3D draughting. This is a perfectly reasonable aim. It should be borne in mind that as the ability of the system (2D or 3D) advances, so will the amount of time taken to master all the subtleties built into the software package. In many cases this will be considerable; possibly more than the home workshop owner is prepared to devote to a fringe activity.

Instantly usable

If you consider yourself to be, or likely to be, an enthusiast, this series is most definitely inadequate for you, do however read on as there may be some snippet of help or interest. For this reason this two part article is based almost entirely on 2D drawing. The review in Part II will be limited to 2D packages that are almost instantly usable.

This assumes you already have a knowledge of using a computer, say from the use of a word processor. (Some information on 3D drawing, not part of this series, is planned for later issues of M.E.W. - Ed.)

The series is aimed at the home workshop owner, who wishes to produce simple drawings of the type found in this magazine. Correspondence to M.E.W. shows that the use of the PC as a word processor is a growing trend; with the PC available it is probably a short step to adapting it as a drawing tool.

I worked in a highly technical industry and saw the use of the personal computer grow dramatically. I noticed the introduction of complex, and then even more complex packages. I realise that for a few users these additional complications are very beneficial; for many they have added unnecessary complications to the basic requirement and thereby extend the learning time.

I am a firm believer that there is still a wide range of uses where the most basic

program would suffice, and would be glad to hear readers' views on the subject.

I saw the demise of the office typist in favour of each engineer having his own word processor. Then followed a time when they, and I, struggled to learn the ins and outs of the £400-00 software package. Eventually, after spending a lot of (Company) time in attempting to learn its capabilities the machine saw very little use beyond that of a typewriter with simple editing facilities.

By now you may be asking "What has this to do with CAD? Well, nowhere is there a greater spread of prices than for CAD. Apologies to those enthusiasts who have written in favour of the expensive packages, and expressing their dislike of some at the cheaper end of the market place. It is a fact however that it is becoming possible to purchase very able programs at prices far lower than in the past.

For the beginner

This first part of the article is aimed at the total beginner, one who has no experience of CAD, and maybe no computer skills. In view of this, some initial explanation of using computers will be given. This will be followed by a general description of the abilities of CAD systems, and then conclude in part two with some investigation into individual CAD packages. The aim of the review to conclude this article will be, to advise on packages which are both relatively cheap, and simple for the beginner to master.

This first part is written to also interest readers who have no intention of setting up a system, but maybe keen to have an insight into its working.

Why CAD?

Let us first consider why the use of CAD should be contemplated. Well, what is CAD? Many people will mistakenly take this to be the initials of Computer Aided Design; this is not the case. The aim is to provide a drawing tool only, design is still established by the operator. Some of the very expensive packages may be able to complete designs automatically, though my only experience of this relates to printed circuit board design, which can, up to a point, be designed by the computer without assistance.

So, what makes CAD preferable to the good old drawing board, and are there any factors against it? Anyone familiar with a word processor, no matter how simple, soon realizes that its main benefit is its ability to edit work already on screen. This can range from a simple correction of a mis-typed character, to taking an already complete paragraph and moving it to a new location in the document. As a result, even the raw beginner can produce presentable documents, if perhaps a little slowly in the first instance. Even so, this will still be quicker for the novice typist, than many re-starts using a normal typewriter. CAD has similar advantages.

Anyone who has designed a new piece of equipment by the established pencil and paper method, will have found problems. At best, the drawing may become crowded and as a result there is insufficient room to add dimensions and notes tidily. At worst, some error or weakness in the design may require major changes, requiring considerable

erasure of the work already completed. It can sometimes be a case of bin it and start again. Whilst not totally eliminating the possibility of a restart, this is likely to be a very infrequent occurrence when using CAD. The ability to edit the drawing as it is being developed, will enable even the most inexperienced draughtsperson to produce presentable images. It is therefore the ability to edit ones work where the real strength of CAD lies.

If CAD has any weakness, it is its inability to display the whole drawing on the screen in a simple, easy to read fashion. Except for the simplest of drawings, most work will be done with only a small portion of the drawing visible, thus making it impossible to rapidly scan the drawing in a split second, as one would with a drawing on the board. Once the operator has learned to live with this, the advantages of CAD will soon become very apparent.

For those without computer experience

Those who have used a computer for other applications, will be conversant with the method of working common to very many programs, that is, menus and drop down menus. For those without such knowledge, the article will attempt an explanation; such information is essential to the understanding of what follows.

Computer operating methods

The method of operating a computer, is frequently to have at the top and bottom, sometimes the side, of the screen, prompts as to the facilities available. The prompts are normally a row of single words known as the main menu; to make use of these prompts some means of initiating them is required. There are in the main three methods of doing this, but to avoid too much complication only the most common method will be described.

To initiate an action there will be on the screen a small marker (the cursor) which has to be moved over the name of the command required. This can take many forms, but an arrow or a hand are most common. To move the marker around the screen a small device called a mouse is connected into the computer. This is placed on to a small mat on the desk, and as it is moved around on the mat the marker follows a similar route. The mouse will have buttons which are used to instruct actions to start and stop, or to be cancelled.

The menus

Understanding the use of menus (think of these as lists of choices available in the package - much as a menu in a restaurant will list the choices of dish available) is perhaps best achieved by use of an actual example. One of the simpler, but still very able CAD packages to be reviewed later, has a main menu with the following titles. Draw, Change, View, Assist, Settings, Measure and File. The most easy to understand is Draw. If the cursor is moved, using the mouse, onto the word Draw, a further list of names will appear below this. This additional list, running down the screen, is referred to as a Drop down menu. **Sketch 1** shows the main menu for the Auto-Sketch CAD system, together with the contents of each drop down menu. In practice only the drop down menu called

QUICK TIP

Not having a special Autolock chuck, I hold my end mills and slot drills in collets.

Especially with small sizes these cutters have a tendency to walk out and/or slip, so a grub screw is necessary to retain them.

Instead of grinding a nick in the stem of the cutter, use a masonry drill to drill a depression for the grub screw. It will easily drill HSS using a slow speed and firm pressure on the drill. **P.A. Twist**

for will be visible, but this illustration serves to show the typical content of a typical CAD package.

The Draw function can be seen to contain such words as Arc, Box, Circle, Line, etc. The cursor, initially used to locate the menu, can now be moved, using the mouse, to one of these. If placed over the word Line and a button on the mouse pressed, the drop down menu will disappear and the system will be ready for drawing lines. The cursor will now be moved, in a similar manner, to the place where the line is to start and a button on the mouse pressed; then to the other end of the line and the button pressed again, with this done the line is complete.

This may sound easy, but how is the line positioned and its length determined? It is obvious that it is impracticable to hold a rule to the screen, so some other method is required. Perhaps it is worthwhile to comment on the degree of precision to which drawing programs work. This is far greater than is possible by manual drawing methods, and far more precise than the limits to which machine tools are generally capable of achieving.

To make use of this precision, two methods of positioning the various drawing outlines are available. The least used, is to position the lines etc. by typing in the co-ordinates by numeric value. This is the only method appropriate when working to complex dimensions. There is a simpler method for the majority of requirements. As the bulk of any design will normally be established around some simple dimensional increment, typically 1mm or, if Imperial, 1/16in., then the drawing can be made to lock onto these increments automatically.

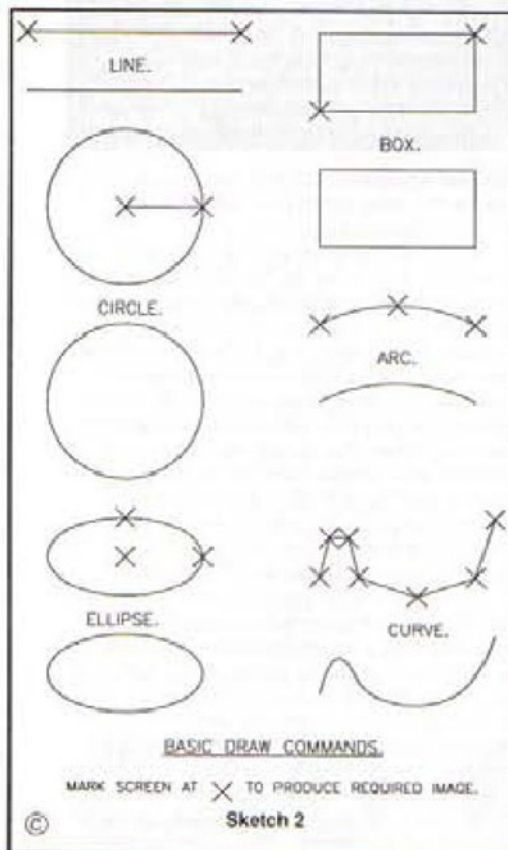
Grid and Snap

Two facilities are available to assist; these are, on most systems, called Grid and Snap. Unfortunately this level of standardization is rarely apparent for other commands. The Grid is a matrix which is displayed on the screen, usually comprising a pattern of dots.

Consider a part being largely designed in 1/16in. increments. In this case, to have a grid at 1/16in. intervals on the screen would be unduly cluttered. To overcome this a second facility called snap is available, this ensures that lines can only start and finish in the incremental positions detailed. In this case therefore, it would be preferable to have a visible grid of say 1/8in. and the invisible snap set to 1/16in. steps. Snap attracts the ends of lines, rather like a magnet. As a result, with Snap turned on, lines can only start and finish at these points. Values for Grid and Snap are set via the Settings menu, more about that later.

Draw menu

This is one of the headings in the main menu, as indicated above. This is one of the easiest for the beginner to understand. The following are a few of the facilities available from its drop down menu. Examples of Draw commands are shown in **Sketch 2**.



Line

Now with Snap and Grid set, via the settings menu, lines, via the Draw menu, can easily be drawn, accurately positioned and length set. Grid and Snap values would be set at the commencement of a drawing, even so, smaller increments can be required for a part of a drawing, and for this their values can be changed to suit. The Snap facilities are usable for all situations where precise positioning is required.

To assist further and to avoid the need to count the grid on the screen, particularly for longer lines, the coordinates of the cursor and the length of the line will be displayed numerically at some point on the screen, probably the lower edge. The display can also include the angle, where the line being drawn is not horizontal. These coordinates will be displayed for all drawing operations, not just lines.

Box

This is another drawing command, creating a two dimensional box. For this, one corner is indicated then the diagonally opposite corner.

Circle

For this, the centre point is marked followed by a point on the circumference and from this the circle created.

Arc

The arc can be established by indicating one end, then a point on the arc, and finally the other end.

Text

Another draw command is Text. This will require setting for type of font, height and width of lettering and other factors, via the settings menu, before entering text via the Draw menu. Text must be called up from the Draw menu and the position for the start of this marked on the drawing. The text is then typed in from the keyboard. The ease with which text can be entered varies considerably from package to package.

Pattern fill

Any enclosed area can be filled with a pattern, which can be from a wide range of available patterns. These will be from a simple cross hatch to something much more complex. Again the pattern will be selected via the settings menu. It will also require some scaling to ensure the pattern is in proportion to the drawing itself. It would be inappropriate to draw a house and for the brick wall effect to show it built from very large bricks, the fill pattern would require scaling down to make the bricks more appropriately sized.

Choose Pattern Fill from the Draw menu, mark the enclosed area using the mouse and cursor, and the area will be filled with the selected pattern.

Other commands

Other commands carried out in much the same way are: Ellipse, Curve etc.

View menu

This is another main menu heading, used for modifying the view of the drawing being displayed on the screen. During drawing operations it will, as mentioned earlier, be required to display small areas of the drawing to view and create finer detail.

Zoom

With the drawing on the screen showing the part to be worked on, but at too small a size, this area must then be magnified. To do this the View menu would be selected and then Zoom from the resulting pull down menu. From this point it will be possible to draw a box around the area to be viewed, the area will then be recreated on the screen as large as the screen will permit. The drawn box is not permanent and will not be present in the redraw.

Last view

Frequently when having left a view to work with a smaller, or larger, area, it will be required to return to the previous view. Selecting Last View will achieve this.

Zoom full

When having been working on a drawing and frequently changing the view, it will not be possible to use Last View to get back to the full drawing. In this case, selecting Zoom Full will result in the whole drawing once more being displayed.

Pan

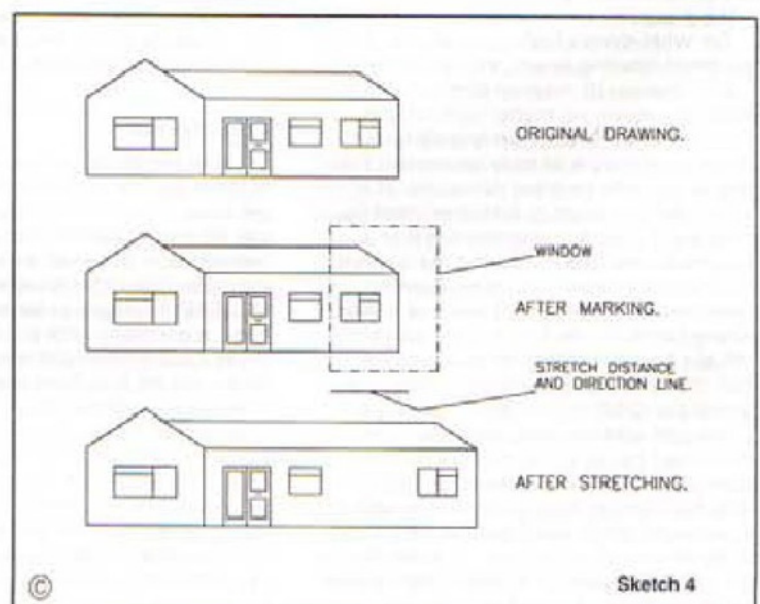
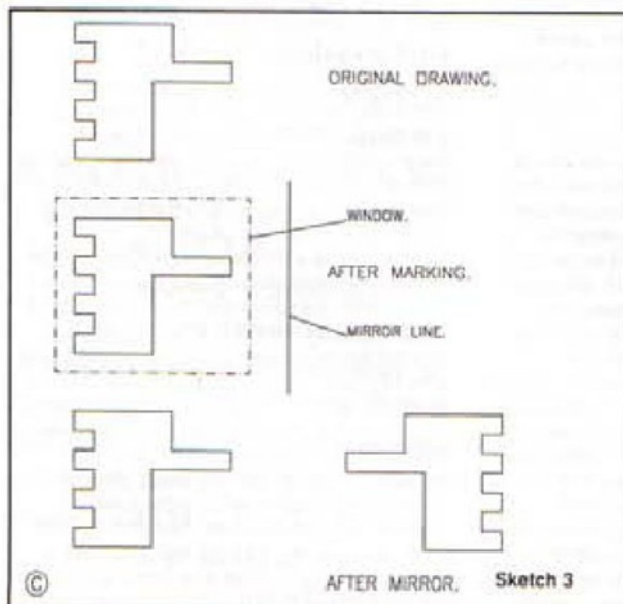
If the view requires to be moved to gain access to parts just off the screen, without changing the size, the Pan command can be used. With this selected, it will request two points to be marked on the screen to indicate the extent and direction of the move. The move can be up/down, left/right, or at any angle. Last View will also work after a Pan command.

Change menu

This menu is the real strength of the CAD system, enabling edits of many forms to be carried out.

Erase

This is a powerful and potentially dangerous command, but one which on most systems is backed up by a command that can avoid expensive mistakes, more about that later.



After selecting Erase from the Change menu, it will be required to mark the item/s to be deleted. The method will vary from one system to another, but the following is one method. If the cursor is placed, using the mouse, on, or very close to (absolute precision is not necessary) the item to be erased, the item will be erased. If on the other hand the cursor is placed in an open space it will find nothing and expect a box to be drawn around the item/s to be erased. Using the box will permit large areas of the drawing to be erased at a stroke, and if done without due care, large amounts of a drawing could be lost accidentally. Fortunately some packages can recover undone and changed work (see undo and redo latter) which is a great time saver, unfortunately others are very limited in this area.

Copy

This is a useful facility enabling areas already drawn to be repeated at other points. As an example, take the end view of a nut, draw a box around it and mark the centre of the nut, then mark where the centre of the copy has to be and the nut will be copied to this point. Another change menu command which is rather similar is **Mirror (Sk.3)**, **Stretch (Sk.4)** and **Scale** also work on an existing portion (or the whole) of a drawing, these permit the size to be modified either in one (Stretch) or both (Scale) directions.

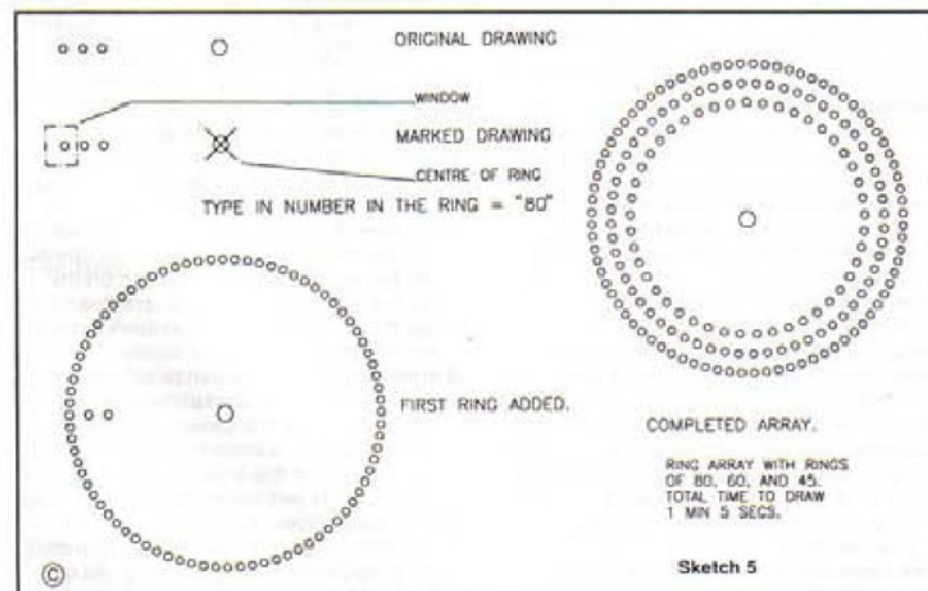
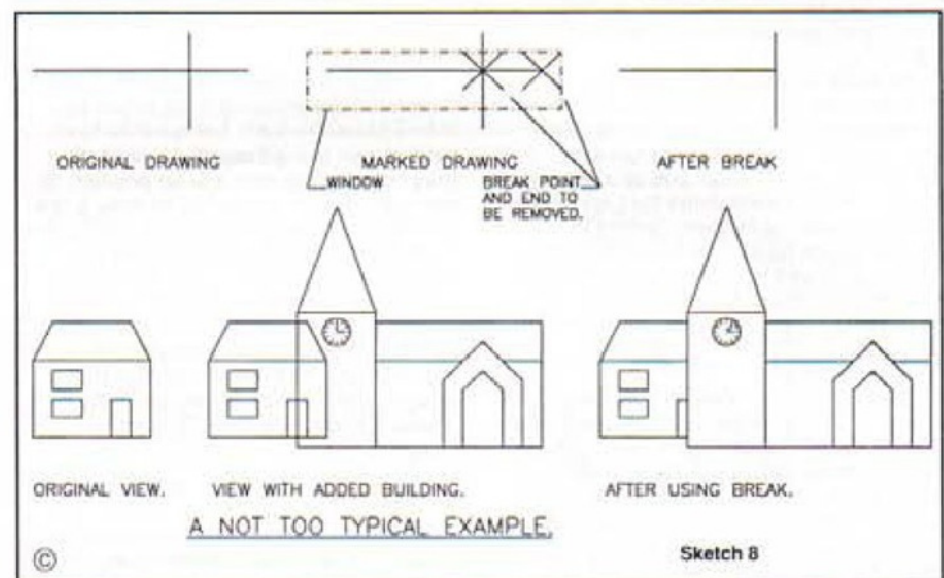
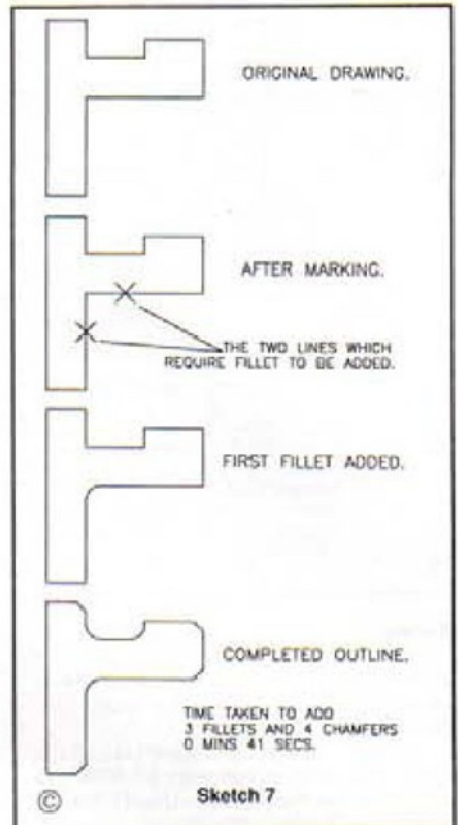
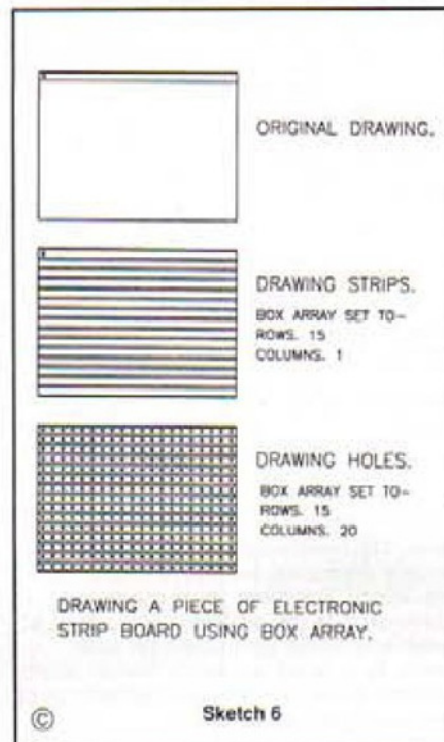
Move

This works in the same way as Copy, except that the existing view is deleted and redrawn in the new position. This is a very valuable command for tidying up the drawing, either during drawing or on completion.

Array

These are two similar commands which have limited use, but are of extreme value when the need arises. The commands basically copy an item, either in a circular format, (Ring Array - **Sk.8**) or linearly, (Box Array - **Sk.6**). Typical of an application for Ring Array would be the generation of a dividing plate drawing (see also Dividing by Computer, M.E.W. Dec. '91/Jan. '92 - Ed.)

A brick wall could easily be drawn using the Box Array, as it is even possible on some systems to offset each alternate row. However, shown in **Sk.6** is a piece of electronic strip board being drawn. This is



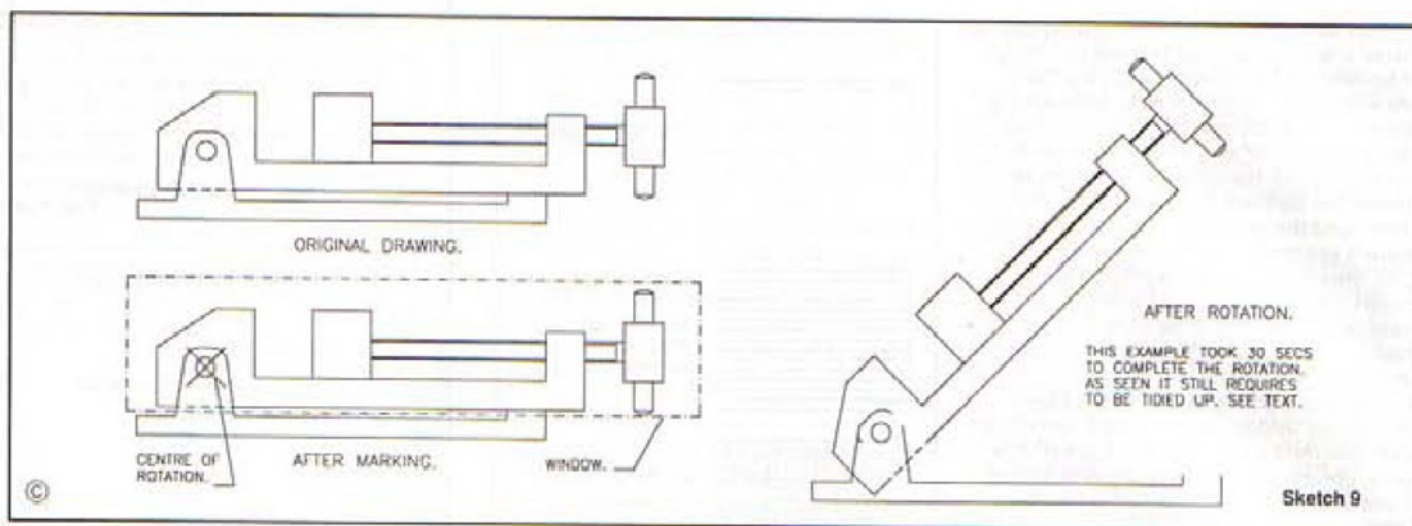
a good example, and would have been drawn in a matter of a minute or two, copying first the strips and then the holes. This method is far quicker than drawing each hole and strip individually.

Chamfer

This will add a chamfer where two lines join, the size being set by instructing the value via the settings menu. The Fillet command is similar. Examples of Chamfer and Fillet are given in **Sk.7**.

Break

When constructing a drawing, the exact start and finish points for some lines will not always be easy to determine in the first instance. This will result in the requirement to erase a portion of an existing line, see **Sk.6**. The Erase command will not perform this as it can only erase complete items. The Break command enables the end of a line, or a portion from the middle, to be deleted. It will also remove a portion from other drawn items, such as a circle.



Rotate

This permits a portion, or the whole, of a drawing to be rotated by any angle. **Sk.9** shows a good example of this in use.

Property

Change property is another very useful command, although its use is unlikely to be obvious to the reader without CAD experience. Many items produced on the drawing are said to have properties, typical examples of this are: Text having font, height and width, or lines having width and type.

All these properties are set in the settings menu. Consider a portion of a drawing having been drawn using solid lines, which, as the design progresses becomes a hidden detail and as a result is shown dotted. First change the Line setting to dotted, and the Property setting to changing Line types. The lines required can now be changed by calling up the Change Property command from the change menu, and marking the area of the drawing to be changed.

Undo and Redo

The potential for disaster was mentioned earlier; if a large amount of a drawing were erased and then found still to be required. Most systems have an Undo, and some a Redo command, but some of these only work on single items i.e. lines, circles etc. Packages that only work on single items will not fully safeguard against this possibility. Similar situations can arise in the case of any complex edit, such as a large Move, Mirror, Stretch, Scale etc. In the case of the CAD systems with the most powerful Undo and Redo commands, the following can be achieved.

Taking Undo first, this will undo the last operation even if it is a complex edit. The Undo feature will revert to the situation prior to the last operation, no matter how complex. This facility therefore prevents the possibility of losing large parts of a drawing by mistake. In its most powerful form, it is not limited to the last item but can step through all the operations since the drawing was last saved to file.

To complement the Undo feature there is, in some systems, a Redo feature, in some systems this can also deal with mass edits. Its function is to reinstate the changes made with the undo command.

Assist menu

This, as its name implies, is a menu providing facilities to assist in the drawing operation, rather than the actual drawing

tasks. The facilities of Grid and Snap, already discussed, are typical of such provisions. This menu must not be confused with the settings menu, which is used to establish parameters for such items. Its purpose is solely to switch on and off (frequently called toggle) the facilities as they are required.

Attach

This command permits lines and other such items to be started or finished precisely at some existing point on the drawing.

Consider two lines which cross, that have been drawn using Snap to position their end points. Even though they have been drawn using Snap, the intersection may not coincide with a Snap position. In this case, if it were required to draw a line from the intersection it would be difficult to position. First set the Attach mode to intersection via the Settings menu, then switching Attach on via the Assist menu. Now with Attach on, if the start of a line is positioned close to the intersection it will automatically find the intersection point exactly. Other attach modes are likely to include Centre, End point, Mid point, Tangent.

Ortho

With this mode on, any lines drawn will always run vertically or horizontally; this can make some drawing operations easier to perform. It may also work, depending on the package, when performing such operations as move, permitting the item being moved to only move exactly horizontally or exactly vertically.

Settings menu

The items in this menu do not perform any drawing function in themselves, but are used to set up parameters for commands initiated in other menus, therefore much has already been said about these. The items set via this menu include the following:-

Grid. Sets the size in the X and Y directions.

Snap. Sets the size of the snap intervals.

Text. Sets the font, height, width and slope of text.

Fillet. Sets the size of fillets drawn.

Chamfer. Is similar to the above.

Units. Used to set whether the drawings are created, and automatically dimensioned, if done, in metric or Imperial units.

Line type. Used to set the type of line being drawn, typically continuous,

dotted, centre etc. These Line types are used for all types of line drawing, such as straight lines, circles, boxes etc.

Pattern. This sets the pattern, such as cross hatching, that will result when filling enclosed areas.

Layer. This facility has not yet been mentioned and so its use may not be obvious. Most CAD packages will enable differing aspects of the drawing to be drawn on what are called layers. This is best visualized by considering the drawing being drawn on a number of transparent sheets stacked on top of each other. Differing parts of the drawing can be ignored by removing one or more of the transparent sheets. The layer settings can control both which layer is being drawn on and which are visible, both on the screen and when being printed.

Attach. Used to determine to which part of an existing item a new line will attach itself. As has already been explained,

It is, at this point, perhaps worth expanding on the question of the accuracy with which CAD systems create their drawings. When using Attach modes, and also Snap, which is in itself a form of Attach mode; lines will be seen to join perfectly when the drawing is being viewed at normal size. If the join is now greatly magnified using one of the zoom commands, such that the complete screen represents a portion of the drawing less than a thou. wide, it will still be seen that the join is perfect.

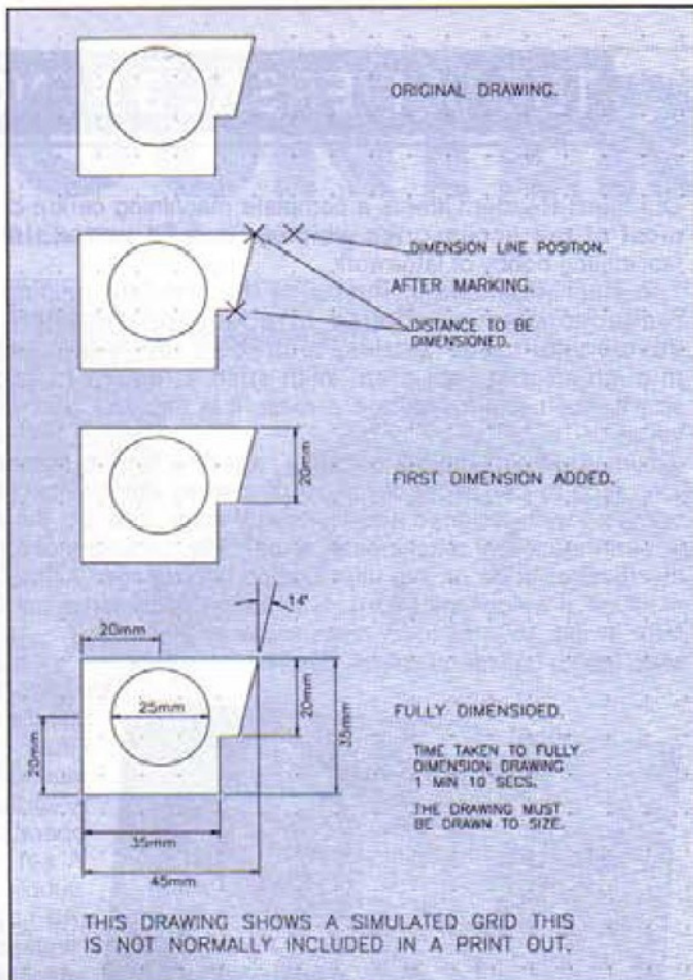
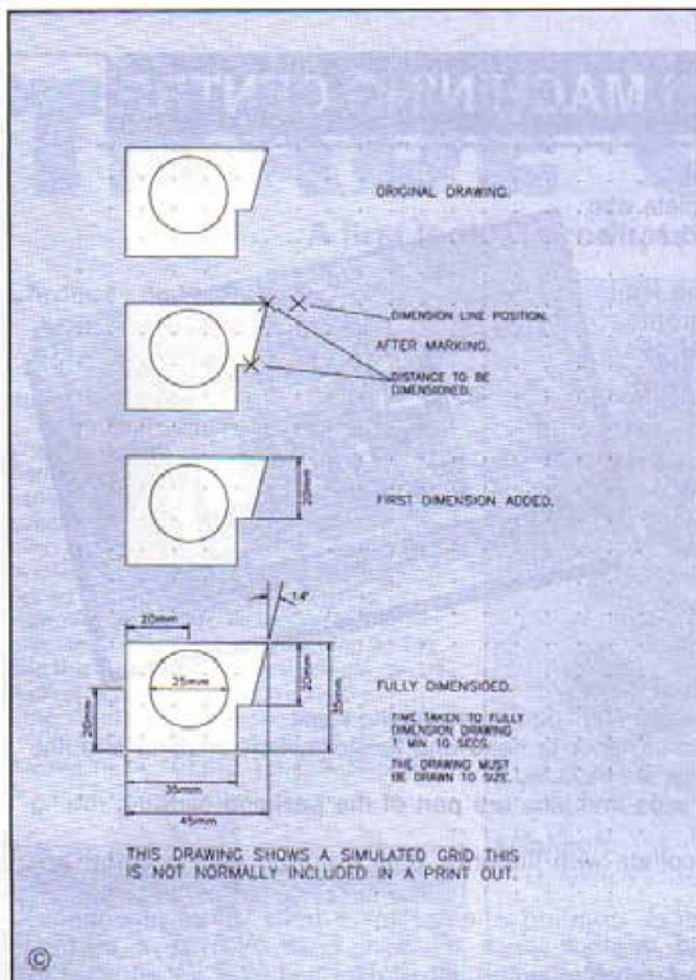
Measure menu

Items in this menu either permit the user to request details regarding the drawing, or to actually add dimensions to the drawing itself. Typical of these facilities are:

Distance. Calling up this command will enable the distance between two points on the drawing to be displayed on the screen temporarily. To achieve this, call up the command and then mark the two points on the screen.

Angle. The angle between two lines can be requested in a similar manner. Mark three points on the screen, the second one being the intersection between the two lines, and the angle between the outer points will be displayed.

Show properties. It will frequently be advantageous to know details regarding existing aspects of the drawing. As an example, consider a requirement to add



Sketch 10

a note to a drawing and for this to match existing text. It will be difficult to determine from the image on the screen the full parameters; height, width, font etc, of the existing text. To obtain these details, call up Show Properties and mark the text in question. The result will display the font, height, width and layer on which it is drawn.

Vertical/Horizontal dimension. One very useful facility of most CAD systems is the ability for dimensions to be added to the drawing with the minimum of effort. For a vertical dimension select this command from the drop down menu. Follow this by marking both ends of the item being dimensioned, and show a third mark to indicate the distance away from the item that the dimension line should appear. The system will then calculate the value and add this to the drawing together with the Lines and arrows as required, this will only work adequately if the drawing is drawn to scale. **Sk.10** shows how powerful is this facility.

File menu

This menu largely consists of commands for management of the actual drawing, typical of the commands which require little explanation are:

Open (brings a new drawing to the screen),

Save,
Print,

New (clears the screen for start of a new drawing).

Others less obvious are:

Save as. Often it will be beneficial to create a new drawing by using an

existing drawing and modifying it to suit. In this case, the original drawing will be opened and brought to the screen, this can then, using the command Save as, be given the name of the new drawing ready for modification. The original drawing will remain untouched.

Part clip. When a section of a drawing is considered as worth retaining for possible inclusion in other drawings, this section can be saved to a file, with an appropriate name, for subsequent inclusion in new drawings. The part will be saved, making it available for entering into other drawings at a later date. This will be done using the Part command from the Draw menu.

Final comments

The above details will, I hope, give a very brief insight into the possibilities of a CAD system, they are only a guide to the main facilities which each will provide. These notes are in no way intended as an operators instruction course on using a CAD system. If you buy the software for such a system your first requirement is to study the instruction book as thoroughly as you would study instructions for any other piece of equipment. If you have a friend who uses such a package seek advice - as with all things in life, five minutes hands on instruction is often worth many hours poring over textbooks. All packages have some facilities which work differently to the explanations given above. They may have other facilities not mentioned, largely depending on cost. CAD packages are commonly available from around £50.00 to £3000.00 highly specialist packages can

cost even more.

If in reading this rather general article, it has whetted your appetite for a CAD system; then the article in the next issue is specifically aimed at you. Unfortunately, if you have no, or very limited computer experience, setting up a CAD system can be fraught with problems. Some computer knowledge, other than just learning to operate the CAD system, will be required. Choice of compatible equipment will be the first hurdle to mount, for unfortunately the major items required all have compatibility considerations. These relate mainly to compatibility of software (the CAD package in this case) to the computer with its software, and the printer. There are also considerations for the monitor and the mouse.

The follow up article can only attempt to give a brief insight into these requirements, but should help, so that the reader need not go to the supplier completely ignorant of the problems. It will be essential however, that much more information should be sought on these subjects before proceeding with a brand new system.

Unless you have a friend who is very knowledgeable regarding computers and who is willing to help, my advice would be to shop around; not necessarily for the cheapest price, but for the package best suited to your needs. Search for the most likely supplier to give the best after sales service. Also choose a supplier, preferably local and not necessarily a high street name, who will install the software for you, so that it will be a case of plugging in, switching on, and away you go. With this approach the finer details of computer management can be learnt, hopefully fairly painlessly.

THE UNIVERSAL 3 BENCH MACHINING CENTRE

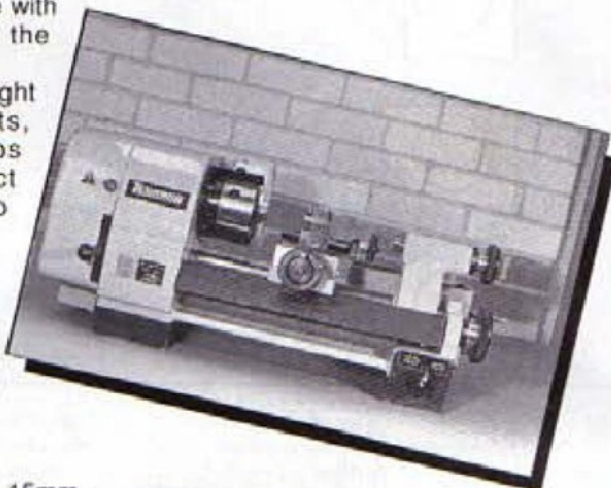
Our latest Reader Offer is a complete machining centre complete with most of the accessories which you need to get started in the fascinating hobby of lathe work.

The machine, made in Russia, is the standard training and light production lathe supplied to educational establishments, development laboratories, toolrooms and small workshops throughout that vast area. With such a range of users, strict specification and quality are a must, it is this that we pass on to you.

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READER OFFER

TRADE COUNTER

A first look at products which may be new to you

Chronos - new catalogue

A new catalogue, No.27, has been issued by Chronos; this can be obtained by sending £1.00 in either coins or stamps, to the address below.

A new item included is a wash-off hand protection, PR88. This is a very effective Barrier cream, which is applied before carrying out dirty operations. Being water soluble it washes off at the end of the job, taking the grime with it, all that is required is water. This, in the latest catalogue, is priced at £12.00 for a 1 litre container. However, as an introductory offer, it can be purchased for £9.95 by mentioning *M.E.W.* and this article. A small free sample can be had on request by sending a s.a.e. to Chronos at the address below.

Chronos Ltd. 95 Victoria Street, St. Albans, Herts, AL1 3TJ. Tel. 0727 832793, fax. 0727 48130.



New DIY Welding videos from BOC

BOC has produced two new videos to help DIY welders and professionals to improve their oxyacetylene and MIG welding skills.

Gas welding (running time 70 minutes) is packed with easy-to-follow instructions and useful tips on oxyacetylene welding, brazing, cutting and heating of mild steel.

Meanwhile MIG welding (51 minutes) aims to bring professional results with mild steel and even aluminium within reach of first-time users of the electric welding equipment. This video comes with its own free booklet covering all the dos and don'ts of MIG welding.

Both videos reflect decades of experience by BOC's top welding specialists. The safe use of gases and equipment features prominently throughout both productions, together with comprehensive instructions on safety procedures, protective clothing, preparing the work area and setting up the job in hand.

Priced at £14.99 each (inc.VAT) both videos are available exclusively from BOC's nationwide network of cylinder centres, or by phoning free on 0800 515 661 (Mon-Fri 0900-1700, Sat 0900-1230).



Minicraft

Minicraft is a name well known to most readers of this magazine. For those who are unaware, it is the small power tool division of Black and Decker.

Whilst most items will be on the small side for most readers of *M.E.W.* a small electric drill will be found very useful where the task in hand is too delicate for the more usual size. Of course if you are into modelling in the smaller scales these drills will be invaluable. For the non modelling reader, they will be very useful for a range of operations, typically drilling small holes for starting screws, or perhaps even smaller holes to ensure that nails enter at right angles when making items from thin pieces of wood.

A recent addition to the Minicraft range is the MB1001 hobby drill set. This comprises an MB1001 drill which is directly

connected into a small plug-in power supply unit, together with some twenty accessories. The drill operates from 12volts DC and has a no load speed of 16000rpm. It is rated at 25W.

On test it was found that it would drill a 2mm dia. hole in bright mild steel quite satisfactorily, taking some 15 seconds to drill through 3mm. A new and very sharp drill was used. The machine is fitted with a nice quality chuck which takes diameters from 0.4mm to 3.2mm. The power supply contains an overload cut out.

The kit sells at around £33.00 and is available from a wide range of national DIY and modelling outlets, also from many suppliers who advertise in *M.E.* and *M.E.W.* For more details contact, Minicraft, Black and Decker Ltd, Meadowfield Avenue, Spennymoor, Co. Durham, DL18 8YG. Tel 0388 420535. Fax 0388 817182. Minicraft Tel 0388 423115.

Craft Supplies

The latest, Autumn 1993, copy of Craft Supplies catalogue is now available price £2.50. This company supplies a very wide range of machines, hand tools and materials for both wood turning and carving. Frequent two day wood turning courses, with accommodation if required, are available. Also less frequently, about 12 times per year, courses in wood carving and French polishing. These are held in Millers Dale, a beautiful part of the Derbyshire countryside.

The catalogue can be obtained from W.H. Smith or by sending to Craft Supplies Ltd, The Mill, Millers Dale, Nr. Buxton, Derbyshire, SK17 8SN. Tel. 0298 871636. Fax 0298 872263.

Planet Manufacturing

Planet Manufacturing, engineers tool makers for 15 years, now have available a new range of toggle clamps. These are made in three types; vertical, horizontal and push-pull. Holding forces for these range from 90 - 450Kg, 27 - 340Kg and 135 - 220Kg respectively.

This type of clamp has a multitude of uses in the home workshop, and being priced from £5.00 to £20.00 they are within the price range of many home workshop owners.

For further details, or to order, contact, Planet Manufacturing, 16A Plantagenet Road, New Barnet, Herts, EN5 5JG. Tel. 081 447 0145.



LINK UP

In response to readers requests a new feature is being introduced into the magazine; this is to enable the exchange of goods and ideas between readers. Read on for more details.

The recent reader survey, together with many letters received since *Model Engineers' Workshop* was first published, indicate the desire of many readers for the magazine to contain a free of charge feature where readers can offer small items of surplus equipment for sale; and similarly advertise their needs.

To some extent, readers needs are already being catered for in *Scribe a Line*, and for a time readers material requirements were attempted to be set out in the trade pages. The *Scribe a Line* approach to readers requests, such as manuals for old machines, has its limitations. If each answer is sent to the inquirer individually this can be time consuming. On the other hand, if answers are held until a number are received an unreasonable delay can occur.

Link up

It has been decided that, initially for a trial period, to try out a new feature called *Link Up* to cater for this and similar requirements. It is anticipated that this will increase the number of requests, probably quite considerably, and will as a result become impractical for all these to be routed via Argus Specialist Publications and then via myself. It is intended that items published will at least contain the writer's telephone number enabling those replying to make direct contact with the inquirer. This should make the process much quicker. Even more important, it will enable the feature to be used for a wider range of possibilities than those at present published in *Scribe a Line*.

If you have some item which you wish to dispose of, or seek some material or practical help, this feature will be the avenue to use. Here are a few possibilities:-

- 1) To sell surplus items at present serving no purpose in your workshop.
- 2) To ask if any reader can supply you with

some special material or part, or alternatively provide details of where such may be purchased.

- 3) Request manuals etc. for older machine tools.
- 4) Beginners may wish to make contact with local experienced home workshop owners who may be prepared to advise occasionally, or perhaps visit one another.

The list of possibilities is of course very long, but if you have a requirement or something to offer, then this will be the feature of the magazine to use.

Scribe a Line will still be used for readers views and subjects of wider interest. Readers requests which may have a wider interest will be published, at the discretion of the editor, without inquirers address, this will enable replies via the office to be considered for publication.

Limitations

It is intended that limitations to the use of this feature will be kept to a minimum. Letters should be written exactly as intended to be published and marked *Link Up*, the editor of course has the right to edit any letter if considered desirable. If any additional comment is to be made to the editor on the subject of the letter, or other subject, this must be in a separate accompanying letter.

There is no limit to the length of the letter, however it should be kept as brief as is possible. In the case of a request for help with an old machine of uncertain make, its type may better be determined using a photograph, (this may be colour or black and white). This will, if provided and of suitable quality, be published (the original will not be returned). Photographs of items offered for sale will not be published.

If intended for publication, the letter must contain a contact telephone number (and general area if something is being

offered for sale, country and area for non U.K. readers) and/or address. Remember, some readers may be deterred from replying if they do not have easy access to a phone, or are from a different country, and an address is not included.

In the case of communications between countries where the cost of a phone call may be prohibitive, and an address has not been given, I will redirect letters. Replies should be sent to me in a sealed envelope marked with the name of the recipient, and an accompanying note referring to *Link Up* and quoting the issue in which the original item was published.

In the case of items for sale up, to five items can be included, providing descriptions are brief, but the total value must not exceed £50.00 excluding postage. Readers wishing to sell items in excess of £50.00 should use the Classified Advertisements section. Similarly in the case of wanted items, the probable value must not exceed this value.

Letters should preferably be typed, but if hand written, name, address and/or telephone number must be clearly written in block capitals. If any doubt exists, the request will not be published. If an item received is not considered appropriate it will be returned to the sender, otherwise all items will be published, though their receipt will not be acknowledged unless a stamped addressed envelope is received. For publication in any issue the request must be received at least 2 months prior to its publication date (three months prior to the first month quoted on the front cover.) Even so publication date cannot be guaranteed.

The facility is available to private readers only and is not available to the trade.

A good start

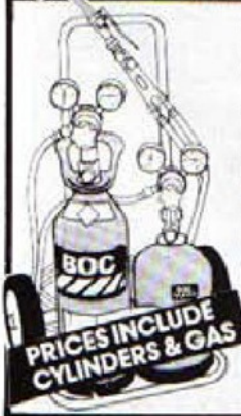
Please send your initial requests in quickly so as to get this new feature off to a good start.



QUICK TIP

To cut small diameter glass tube, all that is required is a small nick with a junior hacksaw and the tube will break off square at that point. It is an advantage though, to wet the surface around the nick as this relieves the surface tension and assists a clean break. **Alan Jeeves**

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ROTATING CENTRE

This rotating centre by Dyson Watkins provides an interesting project with a very useful end product. If you want some experience in the use and mounting of ball races, this is a good starter. The races specified at the end of the article are readily available

The possession of a rotating centre makes the turning of many components much easier, and often much quicker. This is because they can be finished using higher speeds without the inherent problems of local overheating which can be a nuisance when using solid centres. The cost of a commercially available rotating centre can be an obstacle. This accessory is certainly desirable, if not an absolute necessity, so why not make one?

It does require careful and accurate machining, but that is all part of the enjoyment of making your own tooling. On reflection, it would appear that I never make anything at all; just produce tools in order to make more tools. I suppose it takes all sorts.

I decided to make a centre with a No.1 Morse Taper (MT) shank, so that it could be used on my smallest machine. Choose your own MT shank, to suit your machine. The races used are standard sizes and should not be difficult to obtain. They are available from most bearing stockists. You should have these items before boring their housings.

The body

This can be turned from a length of decent quality BMS, or preferably tool steel, the total length being equal to the body length plus whichever MT length is chosen. Grip one end in the three jaw chuck, with enough protruding to machine the taper. Rough out the taper leaving an allowance for finish turning. The taper is short enough to dispense with the need for tailstock support, provided that the finishing cuts are light. Turn the shank to a parallel section first of all; this will be a help in setting the top slide over to the correct angle for the final taper turning operation.

DRG COVER

This is so obvious but still useful. Carefully open your next M.E.W. subscriber's plastic envelope along the top edge. Most drawings and sketches that we do are done upon A4 size paper, so pop your sketch into the envelope clear face outward and hang it up next to the lathe or mill etc. It will keep them clean, no oily finger marks or spots.

Derek Walters

The method I use most often for setting the top slide is to set up a dial test indicator in the tool post with the plunger resting on the now parallel shank. Set over the slide as accurately as possible to half the included angle. This can be a guess at this stage. Next advance the slide by one inch, and check the dial reading with the taper per inch corresponding to half the included angle. Check the accuracy of fit using a MT adapter sleeve if one is available. This check must be carried out at an early stage, because the tang end will not enter the slot provided in the adapter until flats have been machined to form the blade of the tang.

A little marking blue can be used to highlight any high spots, but be sparing in its use. When the correct size is obtained, remove the chuck, and after cleaning out the taper in the lathe spindle nose, mount the newly completed taper in place for all further machining i.e. the bearing housings, retaining collar thread and the outside diameter.

Boring for the thrust race

The thrust bearing must be measured accurately as this will be the first diameter to be bored to size. Drill out the waste as far as possible, before setting up the boring tool. Rough out the bore to slightly less than the full depth and sharpen the tool before the final cuts are taken. It will help to machine the mouth of the bore to the final diameter before extending to the full depth, then finish by winding back to the centre in order to square off the end face. (It is much easier to measure accurately at the mouth of the bore than some distance inside; but make certain that if you are using the top slide to bore to depth, that it is not turning taper). Remember that the radius left in the corner must be small enough to allow the bearing to seat properly onto the end face of the bore. There must not be any appreciable clearance between the bearing outer diameter and the inside of the bore. Ideally the bearing should enter with a small degree of interference. The tolerance is small, hence care must be exercised to obtain the correct fit. It is better to keep on the tight side; even if this means removing the last "gnats whisker" with some fine wet or dry abrasive paper with a few drops of oil added.

Internal screwcutting

When you are satisfied with the bores, then screwcut the 24TPI thread. The first step is to bore an undercut to allow the screwcutting tool to run-out at the end of the cut. Do not make this too wide, as the effective number of threads left in engagement will be reduced, about 1.5 times the pitch will be about right. The depth of the undercut should be the full depth of the thread.

Set up the screwcutting tool angle accurately, use a screwcutting setting gauge if one is available. Use of such a tool is a boon, as it does provide an aid to the correct engagement of the mating threads. If your lathe does not have an automatic

disengagement trip which can be set to the required distance inside the bore, (which is a very useful feature of my old Drummond M type) mark the tool shank to indicate the depth; or put a pencil mark on the bed at the point where the carriage will be when the tool is at the correct depth. Now take a trial cut of about 0.010in., check the pitch with a screw pitch gauge. If all is well take successive cuts until the full depth of thread is reached. It is best to take several cuts at the full depth in order to take the spring out of the tool, and finally chamfer back the first thread.

I should state here at the risk of boring the knowledgeable reader that the screwcutting operation must be carried out at a slow speed, with the back gear engaged.

A reminiscence

Before going on to the next stage, it might be worthwhile mentioning an incident which took place in the apprentice training workshop where I began my apprenticeship. One of the favourite items of equipment we had to make was a milling jack which had a 0.75 in. x 20TPI thread in the body. This had to be screwcut in the lathe. One of the lads completed the screwcutting and chamfered the leading thread, but then decided he would finally polish the mouth of the threaded bore with a scrap of fine emery cloth. As soon as he began this last operation, his thumb instantly screwed itself into the bore cutting a 20TPI thread up to his knuckle; which was duly unscrewed by the apprentice supervisor before the lad woke up from his faint. He was, from that day onwards, affectionately known as 20TPI Williams! I reckon that we should all be fairly safe on this little job unless someone happens to have a thumb of about an inch diameter.

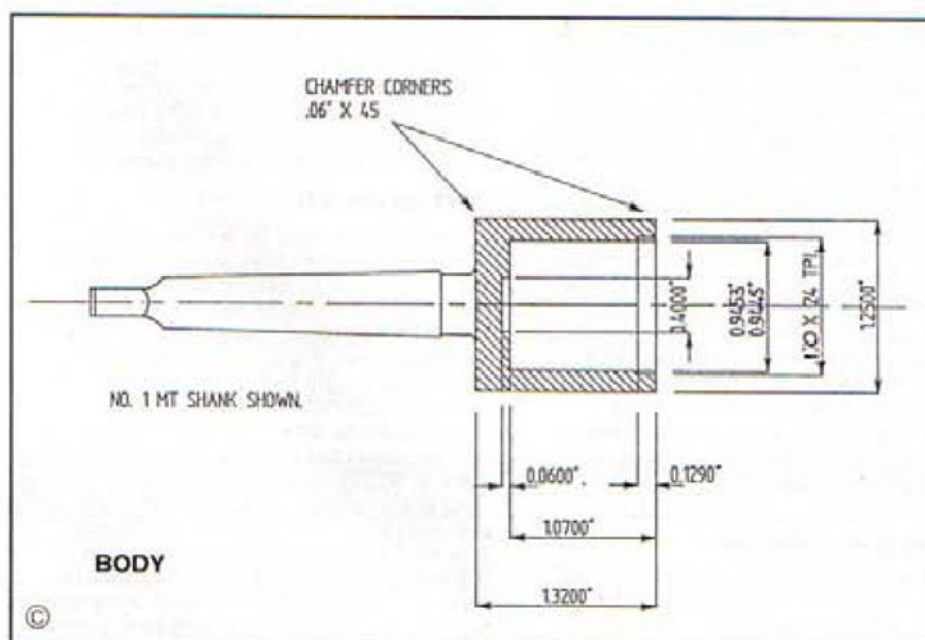
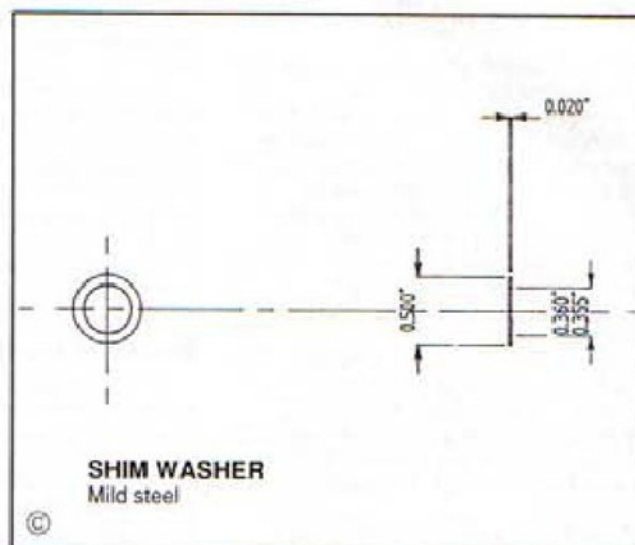
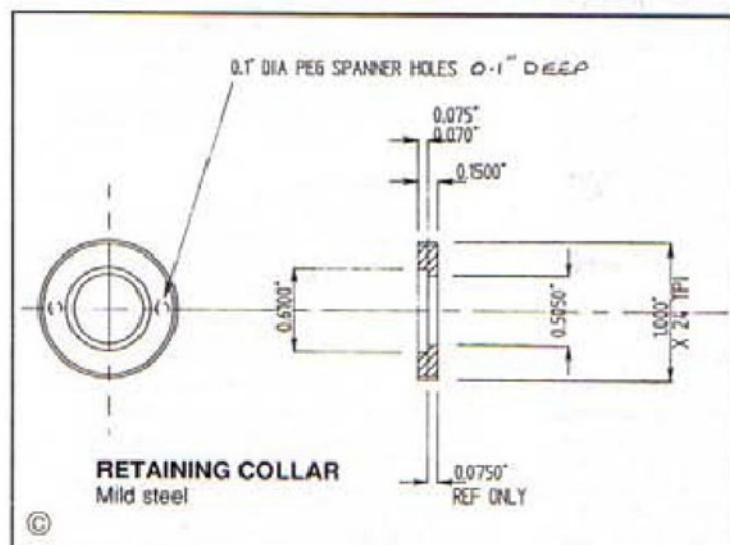
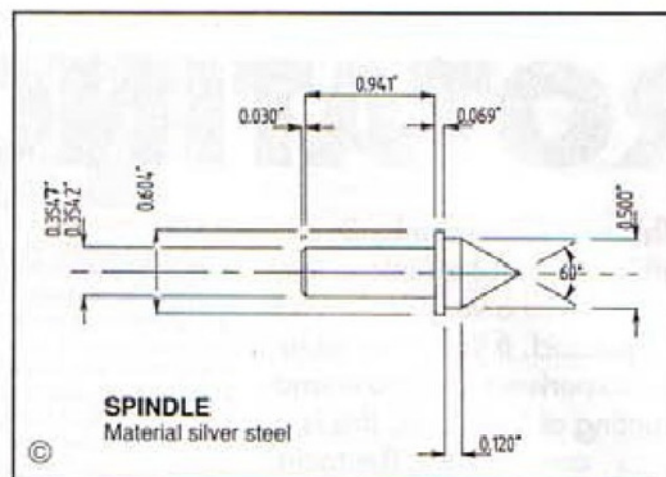
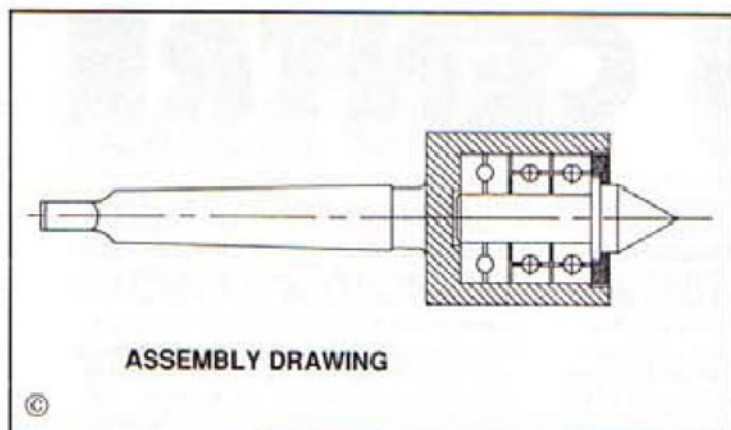
Back to the job

Lastly drill and tap for a small grub screw to retain the collar in position. Mark out the body for this screw after a trial assembly to make sure that the screw breaks through at or near the centre of the retaining collar. A grub screw of M2 size will be about right for the job.

The tang is milled next, if one is required. Some lathes, my own included, do not require the provision of a tang for ejection. I use a lead hammer through the bore of the tailstock. If however, a tang is required, then the body is set up with the vice mounted on the vertical slide, or on the milling machine table if you happen to be an affluent type. If, like myself, you have to make do with a lathe, mount an end mill in the chuck, take a light trial cut along the underside, check the remaining thickness and mill away the remaining waste material. Turn the work over and repeat the operation thus completing the tang.

Spindle (Silver Steel)

The operation sequence for machining this component could be varied according to personal choice, according to the accuracy of your machining and quality of the measuring instruments to hand. My



own choice was to initially hold the bar at the end which will finally be turned to form the conical point allowing about 1.5in. to protrude. Holding it thus will enable trial fitting of the bearing to be made as the work approaches the correct diameter. It is a good idea to turn the 0.942 in. length to about 0.2 in. over length initially, so as to provide a trial length for turning the 0.354 in. dimension accurately. Once this diameter has been produced to satisfaction,

it is then a relatively easy matter to extend this diameter over the remaining length, before finally facing off the unwanted extra portion. Next set up a parting tool in the toolpost and position the blade edge so that the 0.069 in. dimension is produced a little oversize. Feed in the cutter just short of the full depth and withdraw it whilst maintaining longitudinal position. Measure the flange just produced accurately, and index back the top slide to remove the

excess to leave the correct width. If the parting tool cutting edge is 0.125 in. or slightly over, then feed in to depth to produce the 0.5 in. diameter. The next step is to reverse the workpiece, holding it this time in the four jaw chuck. Use the DTI to set the job up to run as true as possible. Next, set over the top slide to 30 deg. (60 deg. inclusive). Set up a right hand tool in the tool post; make certain that its cutting edge is set exactly to centre height.

If the setting height is in any way incorrect, either too high or too low, then the flanks of the point being turned will not be straight. If this point is considered further (excuse the pun) it will be immediately evident that the cutting point must pass through the tip of the point being turned at exactly the centre height of the machine. Take extra care to finish turn to the best finish achievable, so that after hardening and tempering, the point can be easily polished to a good finish without loss of accuracy.

Hardening and tempering

To harden, heat up gently in subdued light to a cherry red colour, and quench in oil. I find that old engine oil is good enough for this purpose, although other oils are usually specified. (If you use old car engine oil for this purpose please first ensure that the container is open to the atmosphere for a good period of time to allow any dissolved unburnt hydrocarbons to evaporate off - Ed). Maximum hardness will not be obtained unless silver steel is

quenched in cold water, but this does entail some risk of cracking, and anyway maximum hardness is not required as this condition also goes hand in hand with brittleness. A tip when quenching is to plunge the component into the oil as vertically as possible, and quickly. Don't lower it slowly like lowering chips into a deep fryer, especially if the component happens to be lying on its side, as this will increase the risk of distortion and the possibility of cracking.

When the part has cooled sufficiently to be handled, test it for hardness with a small file, say on the end farthest from the point. The file should slide over the surface without removing even a scratch. If this condition has been achieved then polish the part in readiness for tempering.

(Tempering is a process which removes some of the hardness, but not all of it, simultaneously increasing the toughness). As this is a small component, tempering directly using a gas torch is a little risky, unless you are particularly adept at it. The problem is that the point is thin and liable to heat up much quicker than the thicker parts. A safer method is to heat up the component in hot sand, which can be heated gently in an old saucepan on the gas stove. Beware of using aluminium pans, they can melt. As the sand is being heated, stir the component around in the sand and watch it carefully for colour changes. The first indication will be a slight change to pale straw deepening in colour gradually. The component should be removed just as it changes to brown. At this stage it can either be allowed to cool in air, or once again quenched in oil, the end

result will be more or less the same. Finally polish.

Retaining collar (Mild steel)

A piece of 1 in. diameter bright MS bar will do for this component if it is set up to run true. Turn to about 0.995 in. dia. in preparation for screwcutting. Set up the threading tool carefully. If grinding this tool point from a blank, take care to ensure that the point is the correct angle for the thread form being turned (55 deg. for Whit. or 60 deg. for metric). The other thing to watch is that the front clearance angle is ground a degree or two more than the helix angle of the thread, otherwise the tool will rub. The trailing angle can be left square. Screwcut a length slightly longer than required and test for fit as the depth is approached. If a slight burr has been thrown up at the crests of the thread during screwcutting, remove it by holding a fine file lightly against it as the machine is rotating. Do this before each check for fit. Next centre drill, and drill out the waste with a drill which will leave a little for finally boring to size. Then bore out the 0.61 in. dia. recess, noting the tolerance on the depth. Finally part off to length. To complete, drill the peg spanner holes to about 0.05 in. deep.

Shim washers (mild steel)

Two are required. These are simply turned to outside diameter, the centre drilled out, and parted off the bar. If the parting tool is well sharpened, there should be no problem from burrs. Clean up the sides by rubbing on an oilstone which will leave them clean and flat if done carefully.

Assembly

Assemble carefully and on no account use a hammer directly on the bearings. If these are tight, it is worth taking the trouble to turn up a short tube which can be placed against the outer rings of the races, and then they can be gently tapped into place keeping them square on entry. If a trial assembly was not attempted due to possible difficulty in dismantling afterwards, the position of the retaining collar will have to be checked by measurement of the individual components. Remember to pack the bearings with a little light grease similar to that used for car wheel bearings, as it is a water resistant type. Do not be tempted to pack the grease in so as to completely fill up the space available, too much can cause overheating. Lastly, assemble the retaining collar, tightening until the spindle cannot be rotated with the fingers. Slacken off about a quarter of a turn and lock with the M2 grub screw, and you are home and dry.

Bearings required

Thrust race - type 51100 (one off)
Ball races - type RHP 609 (two off)

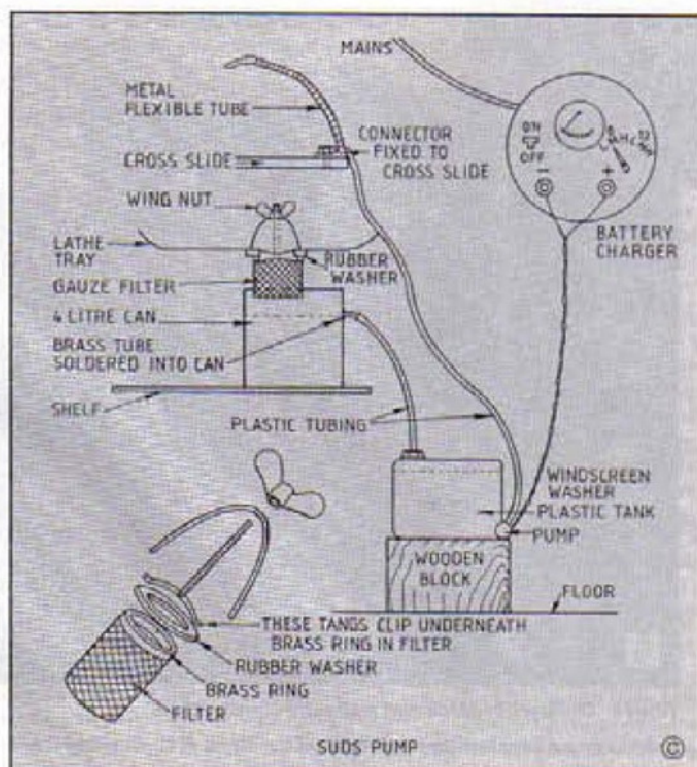


QUICK TIP

An old tip. If you run out of hand cleanser, mix one part of paraffin with one part washing up liquid, shake well and use. Its marvellous.

M. R. Dickerson

AN INEXPENSIVE SUDS PUMP



Using a motor vehicle windscreen washer motor and pump for the purpose of a suds pump on a machine tool is by no means original, many readers have commented on this method in correspondence. However, this brief article by C.W. Plummer in Australia adds a little more detail to the job for anyone attempting it for the first time

I was interested to read of the gravity fed suds set-up, (page 23 June/July 92 issue). I too found the cost of a suds pump far too expensive and tried a gravity fed system. My arrangement fell down when trying to get a jet of coolant into a bore when drilling or fine boring.

I then hit on the idea of a car windscreen washer motor/pump unit as the power source. This was obtained from a car wrecker's yard for \$A10 and connected to a battery charger. My charger has six positions, low, medium and high for both 6 and 12 volts and I seldom need to set the output higher than the medium position on the 6 volt scale. Current at that is approx 1 amp.

About every 5 or 6 months I clean out the gauze filter and settlement tank. This 4 litre can collects most of the sludge from the lubricating oil used on slides, also cutting oil used when threading etc. I have been using this system for 6 years now and it has never given any trouble.

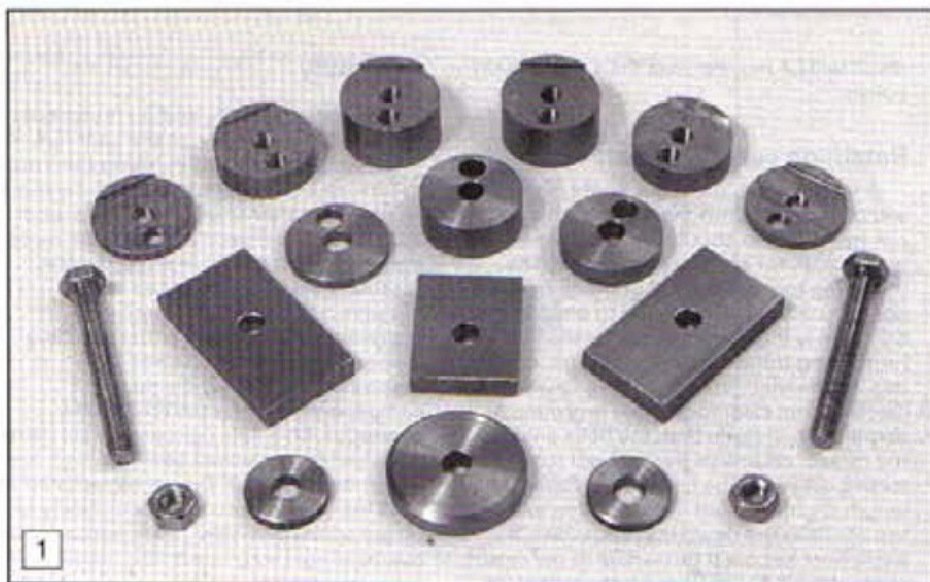
The drawing gives the layout of my set-up and the detail that of the filter.



QUICK TIP

It is interesting and useful to note that BA series screw threads increase in diameter from the smallest to the largest in increments of 13%.

Alan Jeeves



A selection of finished parts.

FACEPLATE/ ANGLEPLATE CLAMPS

The method of holding parallels for machining, described in the Oct./Nov. '92 issue of M.E.W. has been found worth expanding into a much more adaptable clamping system. Readers of all abilities will find these are easy to make and very convenient to use, saving many problems in setting up on what are often regarded as difficult locations

Considering further the method of holding the parallels to the angle plate, as discussed in the article published in the Oct/Nov 92 issue of M.E.W. I have since realized that there is scope for expanding the uses of this method, to the fixing of other items to both angle and face plates. The results of my further researches are the subject of this article.

A shortage of hands

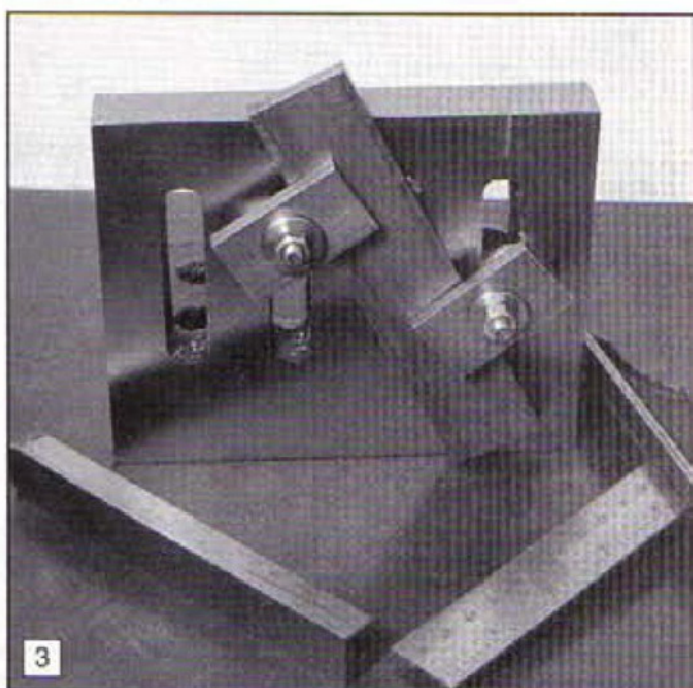
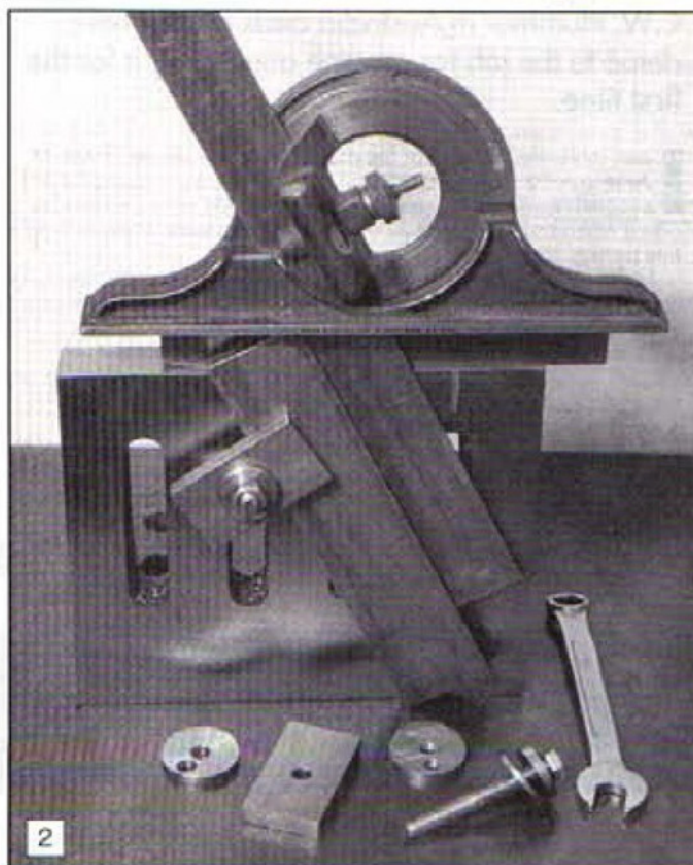
Anyone who has attempted to fix an item to a vertical face, such as an angle plate or face plate, will have experienced the problem of holding numerous items in place whilst attempting to tighten the first fixing screw.

The advantage of the method adopted for machining the parallels was that the clamping screw was fixed in position prior to fixing the parallels themselves. Of course in that case, the post which carried the fixing screw was also used to locate the parallels. Even when the location of the item being fixed must be arrived at by another method, the fixed clamping screw, or screws, will considerably ease the situation.

As the post also contained in its construction the support for the outboard end of the clamp, there is no packing to be manually held in position. This still leaves the clamp plates themselves to be suitably located, as whilst loose they will naturally fall to their lowest position. A little piece of double adhesive strip between clamp and support may help. When the first clamp has been fixed and the workpiece is held in position, two hands will be available for the remaining fixings.

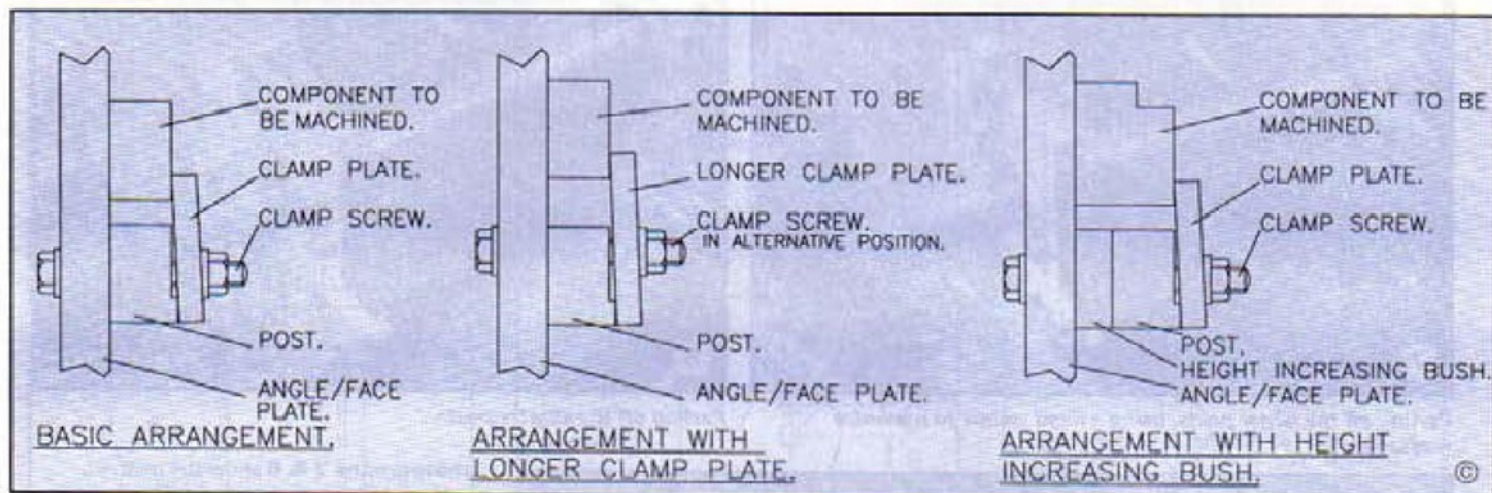
One thickness limitation

The limitation to universal use of the clamp, as described in the article on making parallels, is that it is only intended for a given thickness of item being clamped. It will cover a small range, but this is likely to be no more than nominal to minus $\frac{1}{8}$ inch. For this reason, a range of



Above: The part in place and a second clamp fitted.

Left: Using a single clamp whilst positioning a component on the angle plate.



post lengths with additional extension pieces will require to be made to make the system more adaptable.

If you did not read the article on parallels or cannot fully remember the comments regarding the clamping system, it would be beneficial to re-read this. The three arrangement drawings with this article will also help you to understand the principle. The main problem related to it being used on an angle plate with rather wide slots. To overcome this, at least in part, the expanded system proposed in this article includes a load spreading washer.

One weakness of the method is that the support for the non-workpiece end of the clamp is quite close to the clamping stud and, unless the clamp bar itself is short, clamping pressure will be low. To overcome this to a certain extent a second clamp screw position has been provided in the post. This will make the screw closer to the workpiece and further from the clamp support, an improved arrangement.

A range of sizes

To increase the adaptability of the system, clamps are made in a number of lengths. Longer clamps than those indicated may be considered, though within the confines of an average size angle or faceplate it is doubtful if any longer ones will prove effective in use.

The posts are shown in three heights: $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{3}{8}$ in. high. The range of thicknesses that can be covered is extended by the addition of height increasing bushes. These are suggested in four sizes and extend the range from $\frac{1}{16}$ in. to $1\frac{1}{4}$ in., in $\frac{1}{8}$ in. increments, using up to one post and two bushes. The maximum height using all the bushes is $1\frac{1}{4}$ in. Of course, if this is considered too low, then additional bushes can be made to extend the range.

A few heavy duty washers should be made for use with the clamping screws and nuts, rather than using available commercial standard size washers. Finally load spreading washers are suggested for use when being used on plates with wide slots. **Photograph 1** shows some of the components made.

A compact clamping system

The end result of producing all these components is the production of an easy to use, versatile and compact clamping system. Examples of their use can be seen in **photographs 2, 3 & 4**. In **photograph 2** a part is being set to an angle on the

angle plate, a single clamp is being used and lightly tightened, just allowing the part to be moved to the required position. After this is secured, a second clamp (the parts are seen loose in the photograph) is added as seen in **photograph 3**.

The compactness of clamping systems used on face plates is a very important requirement, mainly in view of the limited space available; one has to arrange to clamp the work securely, and allow for tool access. Safety, and the ability to balance the weight on the plate more easily, are of considerable importance. How well this is achieved can be seen in **photograph 4**, where a block has been added to the faceplate ready for drilling and boring.



Showing the compact nature of the clamps when used on a faceplate.

Useful jacks

Included in the parts made for this set are some screws with smooth faced heads, these are ordinary high tensile screws with their heads faced to remove the markings, then turned with a small radius tool to produce a head with a shallow raised boss. This can be seen in the photographs. With these screws added to the posts, the effect of small screw jacks is achieved, see **photograph 5**. Used with the range of post heights these jacks can cover a wide size range. The height can easily be checked with a micrometer as seen in **photograph 6**.

Thread size

The design uses M6 threads for clamping purposes, these being high tensile hexagon head screws. Anyone intending to use them only on an angle



With added screws they become useful miniature jacks.



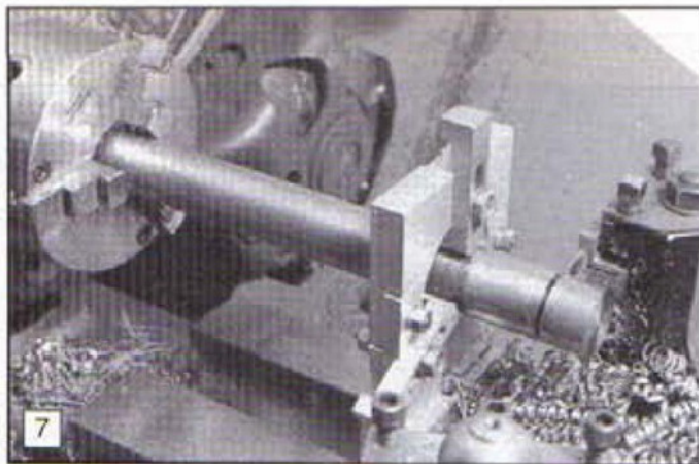
Setting the jack to a precise dimension.

plate, and not on a face plate, may consider this to be on the small side. In this case the studs could be M8. If this option is used, perhaps the post sizes etc. should be increased to $1\frac{1}{4}$ in. diameter.

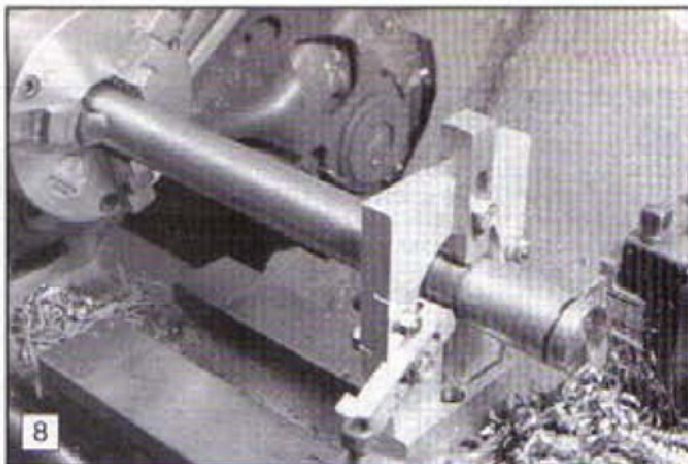
Manufacture

Making the various parts is very straightforward; very little need be said about this. However a few specific points are perhaps worth comment.

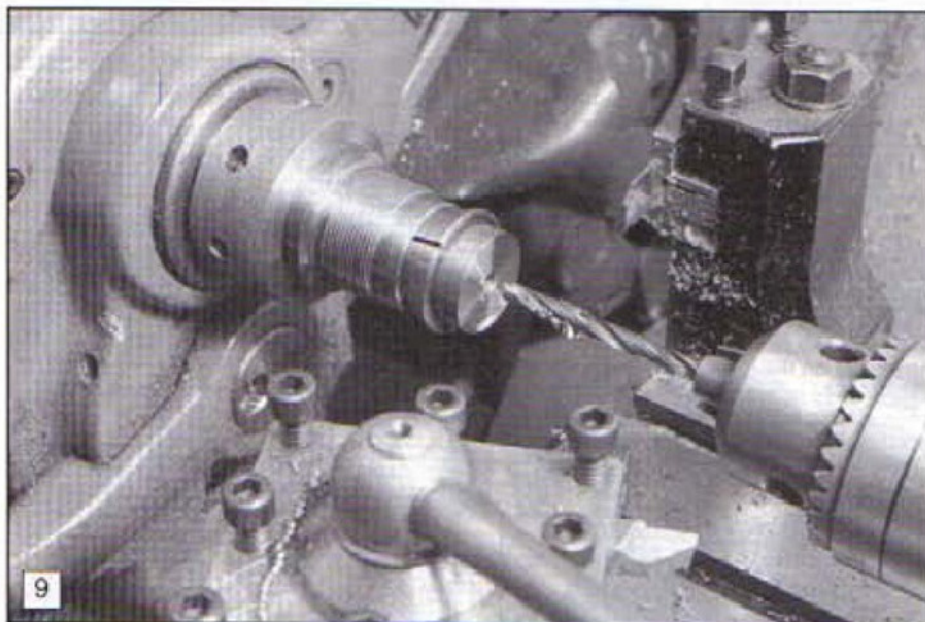
The posts and height increasing bushes are made from 1 in. dia. BMS; if maximum use is to be made of the system at least two, preferably more, of each size should be made. If the material is to be placed in relatively short lengths into the chuck and the parts made and parted off this is likely to end up producing a large number of short offcuts. To overcome this, adopt the method of making the parts from a longer length of material supported by a fixed steady. Using this method of production will keep waste material to a minimum. This is a frequently overlooked use for a fixed steady.



7
Parting off the larger posts, using a fixed steady to minimize wastage.



8
Parting off the shorter posts.



9
Drilling a post using a thin piece collet chuck to secure the workpiece.

photographs 7 & 8 show the method.

Having faced and parted off the lengths as above, the second side can be faced and the central hole drilled using a thin piece chuck. A thin piece collet chuck will assist considerably, in making the turned items as can be seen in **photograph 9**. In fact, such a chuck is probably essential for the thinner height increasing bushes.

The second hole in each post and height increasing bush, intended as an alternative stud position, can be positioned as seen in **photograph 10**. In this case a bar fitted with a short pin, is positioned such that the second hole can be placed first using a centre drill. Two sizes of pin will be required; $\frac{1}{16}$ in. for the clearance holes and a smaller one for the tapped holes.

This will be much quicker and, more importantly, much more accurate than individually marking out each one with a rule and centre punch. The positioning of the bar with pin can easily be done with a $\frac{1}{16}$ in. rod in the drilling machine chuck and $\frac{1}{16}$ in. strip to act as a gauge. The method is shown in **photograph 11**. Do this with a $\frac{1}{16}$ in. pin in the bar, then just change the pin when marking the posts which have tapped holes. The hole position marked with the centre drill can now be drilled through $\frac{1}{16}$ in. dia., or M6 tapping size, as indicated in **photograph 12**.

Milling the step on the larger posts should present no problem, **photograph 13** showing how this can be done.

However thinner posts may present a problem when it comes to holding them securely. In this case first take a piece of $\frac{1}{16}$ in. wide bar and drill two $\frac{1}{16}$ in. dia. holes,

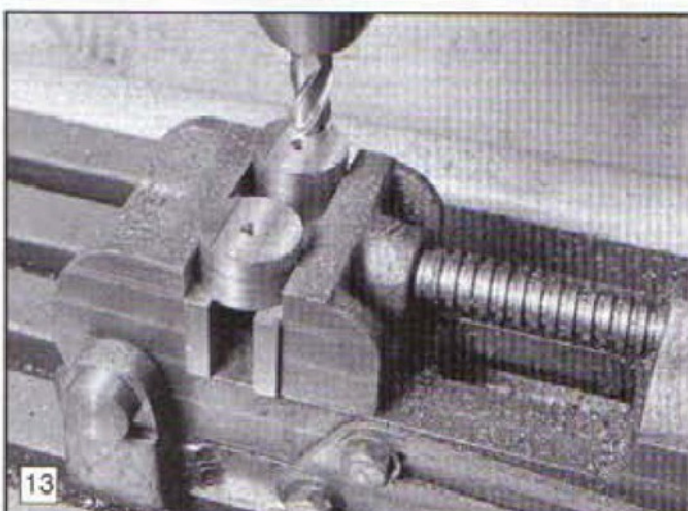
RING RELEASE

If you find that the only way to undo the collet of a Clarkson Autolock chuck is to use an opposing 'C' spanner on the lefthand-threaded damping ring then you may also have suffered from the ring jamming tightly against the chuck body. The solution is to obtain or make a thick nylon washer and insert it between the damping ring and the chuck body. The ring will now be much easier to shift.

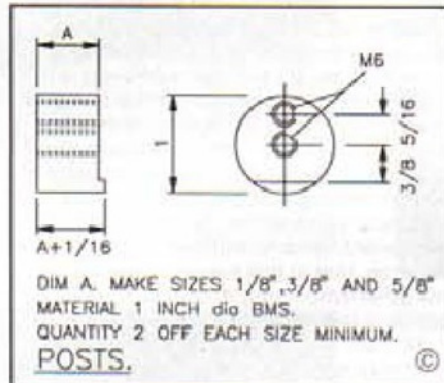
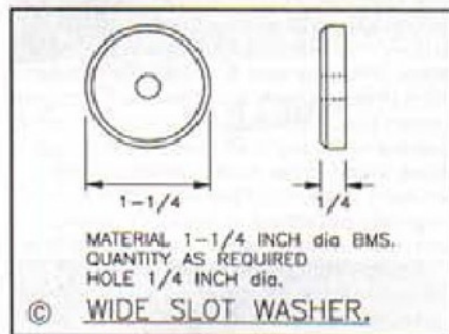
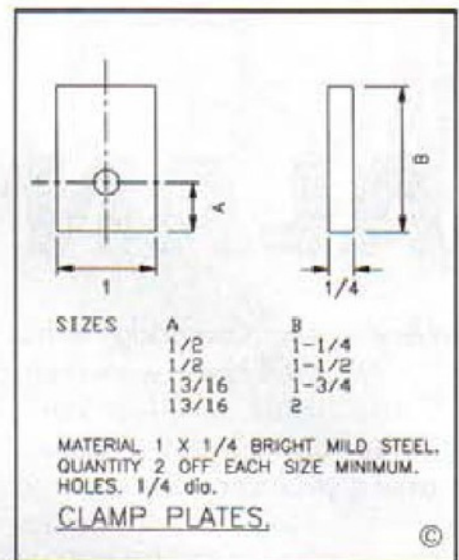
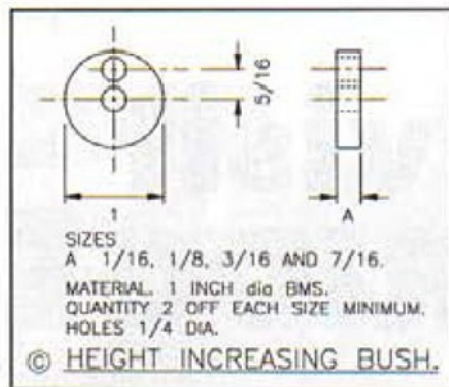
M. Hudson



10
Marking the position of the second hole. Note the simple jig being used to make this an easy operation for a number of very similar parts.



13
Machining the step on the larger posts.

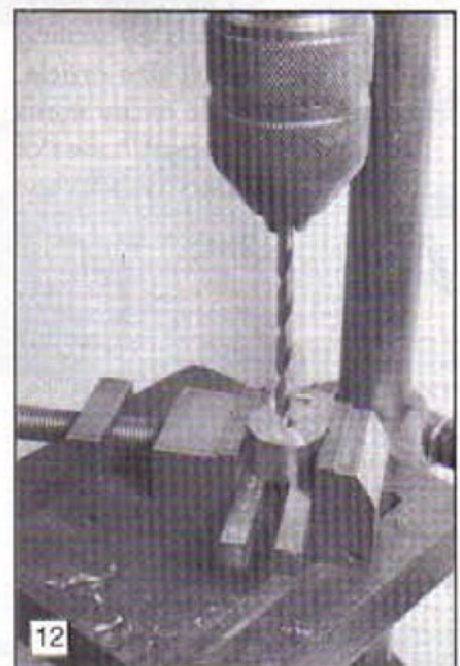


so that the parts can be additionally clamped as seen in **photograph 14**. The step can then be made as in **photograph 15**, machining the end of the screw at the same time.

This leaves the clamp plates and washer to be made, the washers can use the same approach as the thinner height increasing bushes, the clamp plates really require no explanation. If using high tensile screws for the clamp screws, then facing the head to remove the markings and re-chamfering will improve appearances.

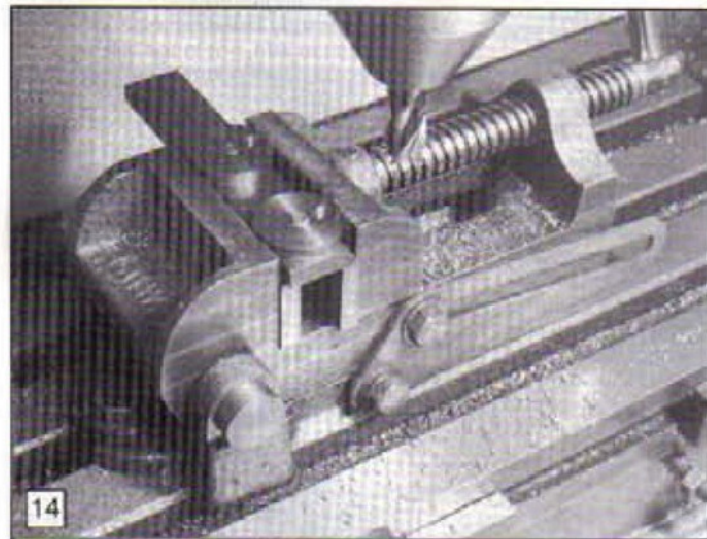
Conclusions

This is a good example of a kit of parts that will find uses beyond that for which they were originally intended. The height increasing posts, being made in a range of sizes, will make useful packers to go under larger clamps being used on the milling table. Also if they are made to a reasonable height tolerance say plus and minus 1 thou. or better if you feel so inclined, then they may find use as small parallels in not too critical marking out applications on the surface plate.

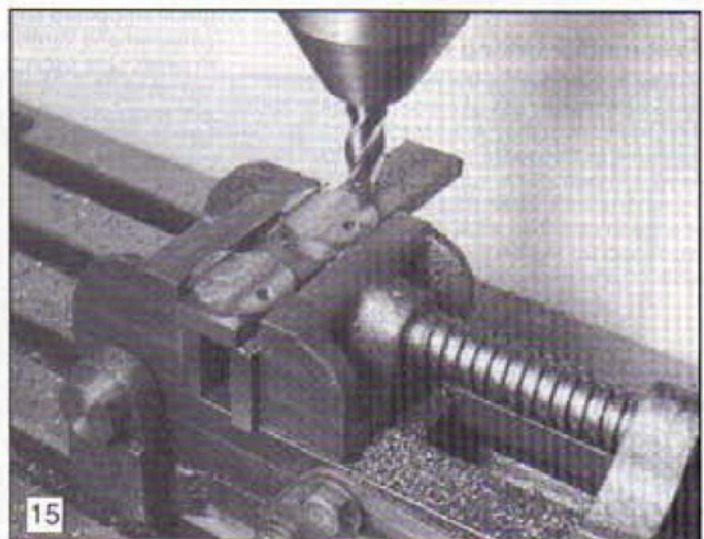


12: Drilling the second hole.

11: The method of initially setting the jig in the correct position.



Fixing the shorter posts to a bar using screws to enable them to be more securely held for machining step.



Machining the step on the shorter posts.

ALAN CAMBRIDGE

We visit -

We visit Alan Cambridge in his first home workshop, constructed some four years ago but only put to use just over a year ago. Read on and see how much he has accomplished in this short time; and how he has made some unusual models by scaling down from the full size article. He has also made many items published in past issues of *Model Engineers' Workshop*

Anyone getting into conversation with Alan Cambridge regarding the history of his workshop, cannot fail to be impressed by how much has been accomplished in such a short time. Long before Alan first started his home workshop, he commenced his working life as an apprentice tool and gauge maker, this with a well known maker of precision equipment, typically slip gauges and the like. After a five year apprenticeship, two years were then spent with the same firm as a universal milling machine operator.

Alan's next move was a change of direction, moving to an electro-mechanical company where he was employed as a draughtsman for some 14 years. This was followed by yet another major change, becoming self employed in the motor trade. This must have been quite successful as it lasted around 20 years, during which time all aspects of motor car maintenance were undertaken, including body work and refinishing.

First metalworking workshop

Had it not been for the need to move home, for the benefit of other members of the family, Alan may still have been occupied in the motor trade. When the need to move arose, some four years back, a property was obtained giving him the chance to establish a full metalworking workshop for the first time. However, whilst the workshop was completed at this

time, the necessity to stay at his original home and commute to his new home at weekends, meant that the workshop was only finished and put into service some 14 months ago. In the short time since it has been commissioned, an immense amount has been accomplished, as can, in part be seen from the photographs which accompany this article. It should be mentioned, so as to truthfully represent the situation, that at this stage he has not taken any other employment, so has more time available than many.

The workshop (12ft. x 10ft.) stands on a solid concrete base and is constructed from 3/4in. exterior grade ply on a 2in. x 2in. frame. The ply is painted externally with a textured finish giving it a very attractive appearance. The overall effect can be seen from the photograph on the front cover. Alan agrees with the article *Keeping rust at bay* (issue 4), which states that it is preferable to avoid workshop windows facing into the morning sun. Plenty of space was available and there was no physical reason preventing this; even so, aesthetically it was preferable for the windows to face this way. To overcome the problem at least in part, the roof is constructed with an overhanging canopy, again seen in the cover photograph. Internally the workshop is lined, and insulated.

Two major features of the workshop are, the form in which the benches are made, and the position of the electrical sockets. To make the workshop easy to keep clean and tidy, the benches are constructed in the form of cupboards that go fully down to floor level. This prevents swarf, and items dropped, from disappearing under the benches, thus making the floor very easy to keep clean. Examples of this can be seen in a number of the photographs.

The bench tops are made from flooring grade chipboard and varnished using a polyurethane varnish; this makes them easy to clean. One exception is the main work top which is steel lined, this can be seen in **photograph 1**. The cupboard doors are also made from substantial chip board, making it easy to mount items on the inside of the doors. **photograph 2** shows an example of this feature. In fact, apart from the machines, very few items are kept in the open. The copious supply of cupboards and drawers makes it possible for all smaller items to be stored tidily and out of sight.

To keep electrical sockets and wiring free from possible damage, these are mounted at a high level. **Photograph 3** shows this feature, the socket being just visible at the top left of the milling machine motor.

The machines

Alan's main machines, have all been acquired in the last six years, with only the two lathes being obtained prior to commencing the present workshop. These

machines comprise a Myford ML7 lathe (**photograph 4**) a Warco VHM vertical mill (**photograph 3**) and two Warco bench drilling machines, one small and the other larger (**Photograph 5**) A second, smaller lathe (**Photograph 6**) is the much less well known E.W. lathe. Readers who have an interest in the history of lathes, particularly those found in the home workshop, will, I am sure, like to read the two letters, originally published in *Model Engineer*, and now reprinted at the end of this article.

Another lathe which Alan owns is a Portass Mark V. This is an older lathe which came his way and which he has no intention, at least for the foreseeable future, to put to use. This lathe can be seen in **photograph 7**, and is, for its age, in exceptional condition.

Another major item of equipment is an air compressor, this is hidden away, in typical Alan fashion, behind one of the bench fronts, but can be seen, with cover removed, in **photograph 8**.

One other large item is an A1 size drawing board. **Photograph 9** shows this and also gives a good idea of the internal finish of the workshop. The drawing board has been arranged so that it can easily be folded flat against the wall, thus making it possible to use the bench top on which it usually stands for other purposes.

A substantial trolley is also available, seen in **photograph 10**. This can be moved to any position in the workshop, or even outside, where some additional working space is helpful to the job in hand

Workshop activity, accessories

The activities in the workshop can be divided mainly between two areas, workshop equipment, and his own brand of model engineering. However, Alan does have a 27ft. ocean going cabin cruiser, presently standing in the back garden, which he has fully kitted out from a bare hull. I hasten to add, not in the last 14 months. No doubt the workshop will provide facilities for this activity also.

It was gratifying to me to see that much of his own made workshop equipment, was to designs published in *Model Engineers' Workshop*. **Photographs 11, 12 and 13** show some of these. Close examination of **photograph 4** will show that the tailstock feed, published in issue 16 (page 30), has been fitted to the lathe. Some of the items have followed the designs very closely whilst others, as is often the case, have been adjusted to suit the situation. Alan has also made the end mill sharpening attachment from issue 14 (page 41) and the cross drilling jig, issue 5 (page 48). In the case of the cross drilling jig, this has been made with a Morse taper shank to suit both headstock and tailstock. This enables it not only to be used as described, with rotating workpieces, but also with a rotating drill and non rotating workpiece.

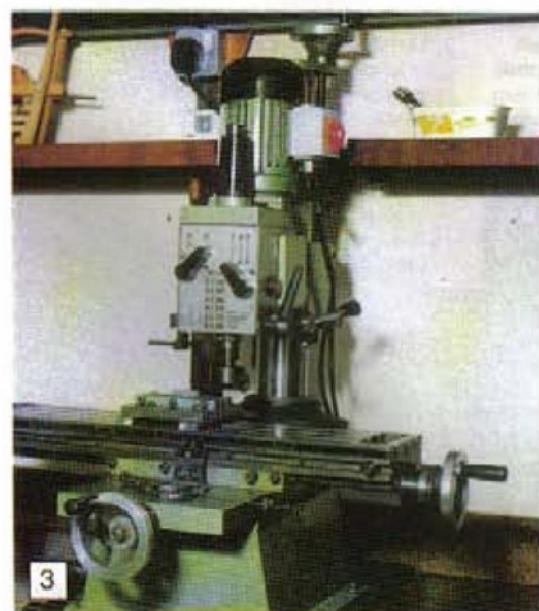
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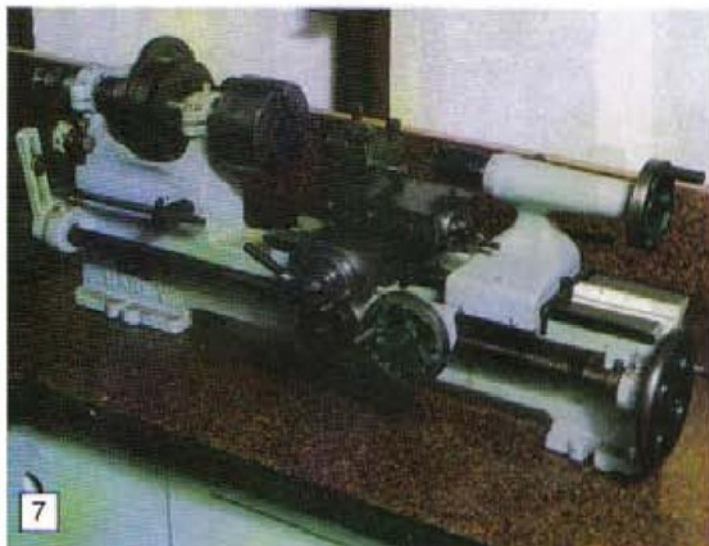
A small 3-corner file as used for saw sharpening should be kept (in a handle) by the lathe. It is the most convenient tool I know for de-burring work prior to parting-off or removal from the machine.

Fettler



1: The work bench with the model of the 1932 "Latil" logging tractor, which is Alan's present modelling project.
 2: Much use is made of storing items on the rear of cupboard doors.
 3: The Warco VHM vertical milling machine gets a lot of use in Alan's shop.
 4: Note the extension for small tools at the headstock end of the lathe. This is made easily removable, by a single screw, should it require removing to make space available for other things.
 5: One of the two Warco bench drills, the other is a smaller one.
 6: This is the E.W. lathe, see the letters reproduced at the end of the article to learn a little of the history of the maker.





7: A Portass lathe in excellent condition for its age. This is not intended to be used, it is regarded as more of a collectors item.
 8: A compressor is available, it is located behind a bench front. A cover is available for fitting over the opening.
 9: A general view of one corner of the workshop, showing the high standard of internal fitting.
 10: A substantial trolley for use wherever required, even outside the workshop on a nice day.
 11: Some items made generally to designs published in the recent DTI accessories series, but to Alan's personal requirements. Note the fine adjuster mounted off the milling head.
 12: Some items from earlier issues of M.E.W. A dot punch, which is a combination of that shown in issue 4 (page 32 and the slide hammer in issue 13 (page 37). An optical centre punch, issue 1 (page 46) and a centre finder, this one from World of Model Engineering No. 3, another sister publication.
 13: Some more items which have been described in M.E.W. Cutter height gauges, issue 7 (page 40) and milling cutter chuck, issue 5 (page 40).
 14: Alan's 1/3rd scale model of an early fretsaw together with the full-size version.
 15: A range of Alan's models with a part complete version of a more recent fabricated fretsaw.

Workshop activity, models

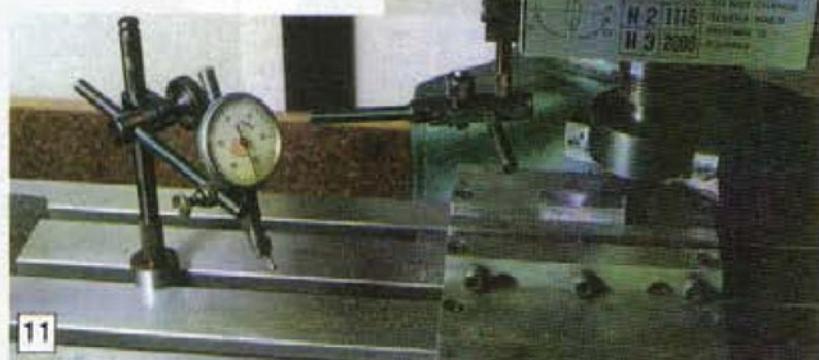
When we come to the models which Alan makes the situation is quite different. Here he does not follow the more traditional lines when it comes to his choice of engineering models, and neither does he work to plans drawn by others.

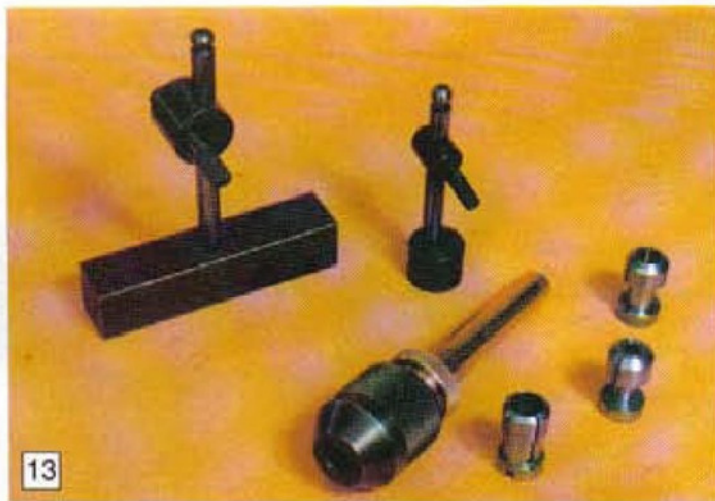
Most interesting is the 1/3rd scale model of an early "Hobbies" treadle fretsaw, seen as the full-size posed with the model in **photograph 14**. Having very satisfactorily completed this; unfortunately the photograph does not do it justice, Alan decided to make a similar model of the later fabricated version. **Photograph 15** shows this in its present unfinished state, together with a model anvil, copy of the one seen outside the workshop, and a mechanical hammer.

Alan's most ambitious model to date is without doubt the 1/2 scale model of a 1932 "Latil" logging tractor, this is of French

origin. A local acquaintance has a full-size preserved version of this marque, kept in superb condition, and this is being faithfully measured to enable an accurate model to be made. This includes the four wheel drive, steering system. Photograph 1 shows this in its present state of completion.

We take this opportunity of thanking Alan for letting us see into his workshop. Perhaps when he has completed the tractor we may return for some more detailed photographs of this and the model fretsaw.





From *Postbag*, M.E. 3 November 1989

E.W. lathes

SIR, - I noticed a request for information on the "EW" lathe. In view of the mis-statement contained, I think it might be a good idea to publish the correct story. It would be interesting to hear what provenance Mr. Simmins' informant could come up with for his story of Edward White.

The lathe was, in fact, both designed and made by my old school friend, John Frederick Stringer. He and I both attended Selhurst Grammar School, Croydon, in the 1930s and started work just before the war; he in a firm at Thornton Heath which made hypodermic needle tubing and I in one which made sight testing apparatus (Ellis Optical Co.). I lost sight of him for a time but around the end of the war joined the Croydon Society of Model Engineers of which he was already a member and was thinking of making a small lathe to market.

Around 1946-7 he started operations, renting space in an engineering works in Islington, North London called "Express Works", which is where the "EW" came from. His only machine tools at first were a 42in. Denbigh Horizontal Mill, a Colchester Triumph 7in. lathe, drilling machine and a Delapena hone. The whole design was arranged for the easiest possible production with this limited equipment, in which he was successful as those who possess one will know. They were remarkably accurate and the honed cast iron bearings gave good life.

But he was up against the heavily capitalised marketing of the Myford organisation, as were all small lathe makers

at the time. One by one they succumbed or switched to other manufacturers and Stringer's lathe operation folded somewhere around 1962-4.

In 1967 I answered an ad. wanting a toolmaker used to working in small shops and found myself working for my old friend, who had found contacts and a new outlet for his energies in the then booming printed circuit industry, making piercing and blanking rolls for PCBs. These had their peculiar problems, but that's another story. He had kept the "EW" as EW Tool Co., S. Norwood.

I worked for him for some 7 years, eventually leaving because the work had become so stereotyped that I was not stretched enough. In other ways, I was sorry to leave and we parted perfectly amicably, remaining in our private lives friends.

Around 1982 he retired to Whyteleafe in Surrey intending to keep some of his machine tools and go in for a bit of model engineering, but it was not to be. He died in June 1985 after some months of painful illness at the age of only 62. A sad end for a kindly and resourceful man, a good machinist but perhaps, like many such, not hard enough to be a business man.

The design of the lathe was really good in principle, the bed required no corebox, the separated headstock parts were simple to jig machine (they will be found to be interchangeable between machines) and the simple and robust slide rest was easily converted with a kit for screwcutting. Of course it lacked refinements, but was sold basically for £17 when it came out, a real "poor man's tool".

Roger Davies
Coulston, Surrey

From *Postbag*, M.E. 3 March 1990

E.W. Lathe - further information

SIR, - I was so pleased to read Roger Davies' letter in the *Model Engineer* 3 November 1989 concerning the E.W. lathe, as I am highly delighted owner and user.

However, the "E.W." story does not quite end in 1964, as I bought my model in 1971, so the following may be of interest to you.

Apparently, the rights to manufacture the lathe were sold to Bonds O' Euston Road who, in 1970, sold the rights to Janap Engineering Ltd. Janap had converted an old railway station at Tregaron, in what was then Cardiganshire and had a very extensively equipped machine shop there. They also had a sales office in Basingstoke, Hampshire. They laid down an initial batch of 50 lathes, one of which I bought and which I collected whilst on holiday in Mid Wales from the works.

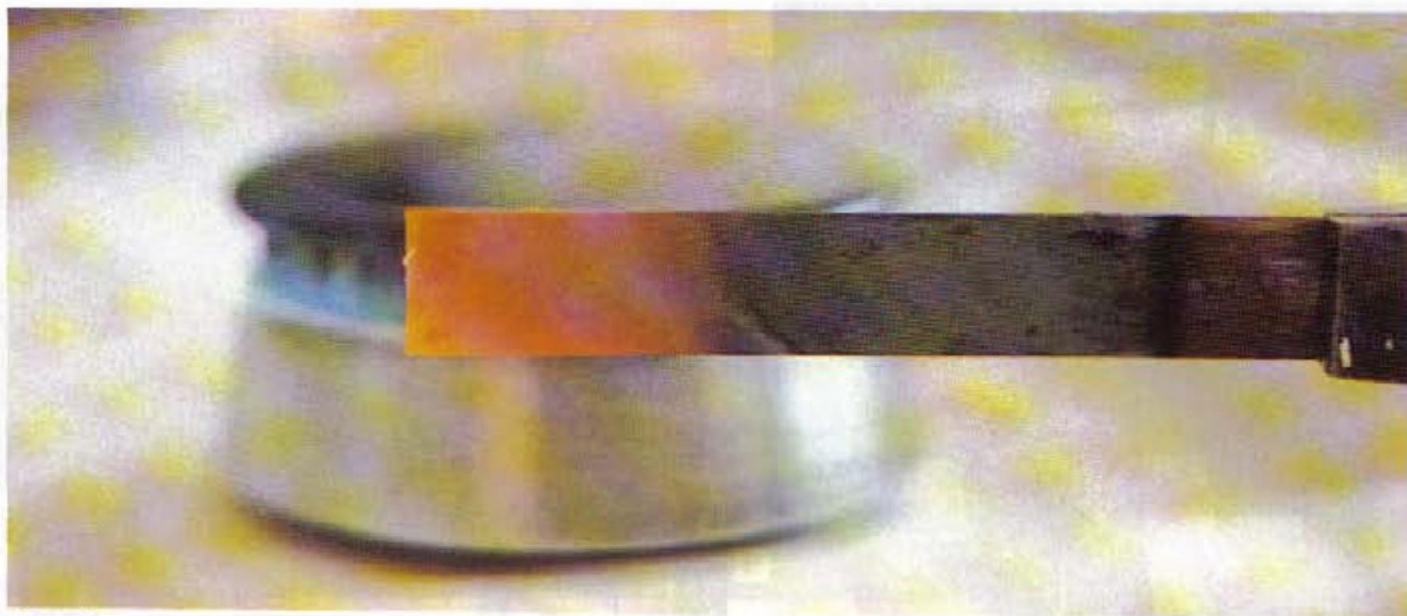
Janap's main business was that of sub-contract precision engineers, but I understand that one of their main customers when out of business, which in turn, put Janap into liquidation. Everything was sold by auction and I did enquire about the E.W. tooling, but sadly, that had been sold for scrap. A sad end for such a fine small lathe, as mine has given me nearly 20 years of trouble-free enjoyment.

Chris A. Shaw
Mottam, Cheshire

QUICK TIP

Although the thread angles are different, it is usually possible to interchange B.S. Brass threads and B.S. Cycle threads from 1/4 in. up to 3/4 in. diameter.

Alan Jeeves



When the steel scales at red heat it is at hardening temperature.

THE PLAIN MAN'S GUIDE TO MATERIALS



The tempering colours.

PART 1

In this, the first of a three part series, Mr. R. J. Loader outlines his knowledge about the composition, use and machining of a wide range of engineering materials. He has gained his knowledge during a life long involvement in the metalworking industry. He starts with information relating to ferrous metals. Part two will deal with non ferrous metals, concluding in the following issue with non metallic materials.

The subject of engineering materials, what we use them for and how they will behave when worked, can be quite a complicated science. It is a technology in its own right, but to paraphrase a well known saying, 'Technology baffles brains'. For most of us model engineers, the need to know is confined to the essentials of how a material can be shaped, cut or otherwise used.

The most important group is the irons and steels and **Fig. 1.** shows the range of the ones most used, some of the less common ones have been left to deal with later. The table shows those which are an alloy of iron and carbon with very small

amounts of other elements, sometimes put in deliberately; sometimes there because they are impurities which are difficult to exclude. Iron is the base material, usually over 90% of the total,

Cast Iron

This is the top of the tree for carbon content. Iron will absorb up to about 1.7% of carbon and above that the metal gets saturated with it, any more will be what is called 'free' carbon, meaning that it will be particles of graphite. Of the many grades, the one we see most of is grey iron with about 3% carbon. It is used for machine beds and parts, surface plates, miniature locomotive wheels and cylinders, angle plates and anything which is easier to cast than shape by other methods. Imagine, for instance, hacking out a spoked wheel from solid. It would take a long time, be very tiring and waste a lot of metal. Ease of production is not, of course, the only reason. Cast iron is very fluid when it is molten, so it will cast into very intricate shapes; it is also one of the quickest ways of going from raw material to finished shape, with but little machining to do, making the casting process one of the best.

Cast iron is brittle and weak when bent,



The point of a tempered centre punch.

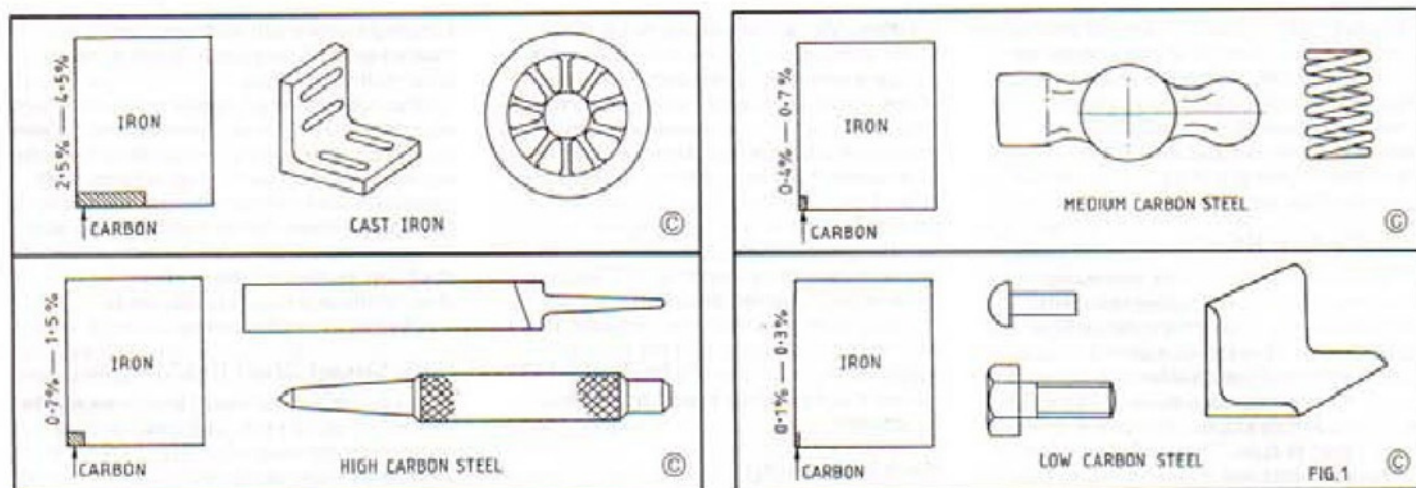


Fig. 1: Iron and steel - carbon percentages.

twisted or stretched, but very strong when compressed. It absorbs vibration, knock a piece with a hammer and it doesn't ring, try the same on a piece of steel and notice the difference. This tends to promote vibration free machining when it is used for machine parts, and the graphite in it acts as a lubricant to make it slide easily in vee and dovetail slides and slow and medium speed bearings. It scrapes beautifully, as long as the scraper is kept sharp.

Machining it is reasonably straightforward and for turning, needs a rake angle of about 5 deg., minimum clearances so that the tool is as strong as possible and a slowish cutting speed of something like 50 ft./min., slower if it plays up. The hardest part of any casting is the outer skin, so the first cut must be deep enough to get under it. The swarf produced is bitty and makes a lot of blackish-grey dust, which will stick to machine slides and grime into hands. Don't knock it, it is the graphite, the internal lubricant which allows it to be cut dry. Cooling can be a problem with continuous cutting, but the slowish cutting speeds aren't so likely to make enough heat to be a problem. Be careful when taking heavy cuts because they cause crumbling or chipping at the edges. This is especially likely when milling or when the cut is interrupted. Angling the tool to the direction of travel helps because the angled edge makes the run-out progressively smaller.

Drilling, tapping and reaming are all quite easy, but when filing, choose the newest file in the rack. If the file teeth are at all worn, it will skid over the surface and not bite. When there is a lot to come off, especially from a broad surface, a chisel is useful. If hacksaw cuts are made across the surface at 1/4 in. or so intervals to almost the depth needed, so that it is crisscrossed, it will chisel off very easily, saving a lot of filing. To stop the bits flying about, rub some Vaseline into the grooves, they will stick to the job and can be picked off afterwards.

Cast iron won't forge; it can be joined by bronze welding or cast iron welding. Joining by soldering or adhesives isn't very successful. Paint takes to the cast surfaces but not so well to the machined ones. One final observation: I wish that non-technical people would get out of the habit of saying, 'hard as iron', because more often than not it isn't true. Some irons are very hard, but they aren't the ones we use most.

High Carbon Steel

This ranges from 0.7% to 1.5% carbon content. I always think of it as one of the magic metals because of what can be done to it. Starting with a steel which can be cut and shaped quite easily, it can be made very hard simply by getting it red hot and cooling it very quickly. It will then be hard enough to cut other metals. Reverse the process, bring to red hot again but cool it very slowly this time, and the magic works again; that which was hard is soft once more.

It isn't magic in the wand-waving sense of course, more to do with the metallurgical changes which happen when a steel contains the right amount of carbon. At red heat the iron and carbon form a solid solution of a material called *austenite*, in other words the two materials become one and change their form. If *austenite* is cooled very quickly it changes into a different material again called *Martensite*.

Martensite is very hard and fine grained, too hard for most uses because hardness and brittleness go together. A little more magic though, can reduce the brittleness by reheating slightly to temper the steel. More about tempering later. The changes I've described are somewhat more complicated than my simplification; if you want chapter and verse there are many books and millions of words in libraries.

In the higher range of these steels, above 1.0% carbon, the steel is called carbon tool steel and its products include: files, scrapers, some hacksaw blades and the cheaper taps, dies and reamers. They will all cut very well and will continue to do so as long as they are used for slow cutting like files, or if not, kept cool. Above 200 deg. C they begin to lose their hardness and by the time they have discoloured to blue, they will have stopped cutting and will rub. The material can be used to make all sorts of cutters and tools and is very good but won't stand heat.

Two good examples are silver steel and gauge plate, each having 1.0% carbon and very small amounts of other elements. Silver steel is a very versatile metal and will make all sorts of cutters, punches and light duty chisels. It is called silver steel because of its ground finish. The charming story that the melters used to throw a silver half-crown into the melt for luck isn't true: nor is it true that the standard length is 13 in., to give a bit extra over the foot for cutting. Thirteen inches approximates very closely

to a third of a metre, so the conversion to metric is easy. Lengths are cut from the finished bar by grinding and the heat generated causes localised hardening on the ends, it is only skin deep, but will take the edge off the tool, so it is a good idea to saw off a sliver before starting to cut. The ground diameter is good enough to use for dowels or as measuring rollers.

In the soft state silver steel and gauge plate machines and files easily. For turning, use a rake angle of 10 deg., a freshly sharpened tool and a cutting speed of 50-60 ft/min. It is best to use high speed tools or, if you have them, carbide tipped ones. Silver steel forges well and is a good material for making screwdrivers, suitably hardened and tempered of course.

Chisels are made from a steel having a little less carbon than silver steel, about 0.85%, because they have to be a bit stronger than other cutters to resist the hammering they get; remember, the more carbon, the harder the steel, but hardness brings brittleness as well.

Medium Carbon Steel

As the amount of carbon in steel reduces, the brittleness in the hardened state also reduces and if this is combined with tempering, the steel can be very strong indeed. Medium carbon steel has from 0.4 - 0.7% carbon; it is used for springs, hammer heads, crankshafts, high tensile bolts and components which have to take a lot of stress. It forges well but needs a lot of muscle to move it if it is a big job. It is used for drop-forged components and some spanners.

When machining medium carbon steel, it will need adequate cooling because it gets very hot. Turn it with a rake angle of 10 degrees and a cutting speed of 45 ft./min. because it is not so easy to cut as silver steel, you may find that the speed needs to be slower. It can be supplied as a forging or as black bar, so there could be a scale on the surface. If there is, treat it as if it were a casting and get well under the scale with the first cut. Feed rates should be as high as will give the finish you want because if the tool is allowed to loiter it will rub and this can cause work-hardening. Filing is hard work on large surfaces, so use a hacksaw as much as possible with high speed steel blades; medium carbon steel will wear carbon steel blades out very quickly, especially the ones used in junior saws. Despite these problems, it is an

extremely useful material: a good example of its use is the making of cap and socket screws and bolts. These are made by forging with rolled threads, so that no cutting has been done and there is no waste. The method also makes good use of the metal's forging quality and preserves the grain structure.

Low Carbon Steel

With below 0.3% carbon, this steel, called mild steel can be dead mild with very little carbon, used for conduit tube and nails, a very soft steel, or with a bit more carbon it is the mild steel we use so much for machine parts, nuts, bolts, rolled steel sections such as angle and channel and many other shapes. These are just a few of the things mild steel is used for, because if high carbon steel is the hard one and medium carbon the strong one, mild steel is the versatile one.

It is easy to join by soldering, silver soldering, brazing, bronze welding and fusion welding. It forges and rivets easily and can be bent cold in the thinner sections. Even with my limited equipment, I can bend $\frac{1}{2}$ in. with no trouble. Be careful though, when bending cold rolled or drawn mild steel against or across the grain and if there is any doubt, or the bending is severe, soften the job first, by heating.

Mild steel machines very easily with a rake angle of 20 deg. for turning and a cutting speed of up to 100 ft./minute. It files and saws well and a hacksaw, junior or otherwise, will do the roughing out as will a tension file or coping saw. The only bad thing about mild steel is that the carbon content isn't enough to harden it by normal methods.

If a hard surface is needed it can be case-hardened, a process which can be an easy one to give a thin skin of hardness, or a more complicated one to give more depth.

Case hardening

The easy and quick way uses a powder called Kasenite, which is rich in carbon in a form which is easily absorbed by mild steel at red heat. The mild steel part is heated to bright red and dipped in the powder or sprinkled with it. My favourite way is to fill an old tobacco tin with Kasenite, put the red hot part in it, cover it with the powder and leave for a minute or two. The powder will stick to the metal and it can be reheated and held at bright red till the powder melts and stops bubbling and

seething. While it is still red hot it is quenched in clean cold water. The result will be a very hard outer skin a few ten thousandths of an inch thick and the tough mild steel core. It is an extremely useful treatment which will protect small parts from wear. It is not a coating, so the work retains its original dimensions and accuracy. repeating the dipping or sprinkling and heating may increase the depth of case but it is a long and tedious job and hardly worth the effort.

When a large component is quenched, it will make a loud bang and the folklore suggests that the louder it bangs, the harder it is; I've never found any such connection.

Pack hardening

This is the method used to give a deeper case of hardness and unfortunately, it needs equipment which the amateur is unlikely to have. The best thing to do if you have deep case-hardening to do is get to know someone at your nearest college or take a model engineering course for a term. They will probably have the facilities and there will be other useful things you will be able to do with the remaining time.

The component to be treated is packed into a heat resistant steel box, surrounded and covered tightly with charcoal chips and the lid sealed on with fire-proof cement. It is heated in an oven to 900 deg. C and left for the carbon to absorb. It takes a long time, usually all day and most of the evening, because the steel absorbs the carbon at about 0.010 in. per hour at 900 degrees. It won't be any harder than when it was put in, because the process is carburising, giving the outer layer of the component the carbon it needs to enable it to harden. When the time is judged to be enough, the oven is switched off and left to cool. The component can be then be taken out, heated to hardening temperature and quenched, this hardens the case.

Pack-hardening does the same as the Kasenite, but it takes hours instead of a few minutes and the case is a lot deeper. I had the pillar of my milling/drilling head for the Unimat done by pack-hardening. A good friend, Jim Taylor, did it for me; he had access to the equipment. He did an excellent job, producing a case of about 2mm deep over a length of 310mm, on a diameter of 30mm. He has moved to the wilds of Perthshire now, but if you ever read this Jim, thanks. It came out dead straight, so it was a doddle to grind to finished size. Had it been a stressed part, Jim would have refined the core after hardening, a necessary operation because one of the effects of keeping mild steel at high temperature for a long time is that the grain of the material grows coarse. Luckily it isn't the sort of problem which crops up too often with the sort of job for which we are likely to use case-hardening. The pack-hardening method is very good for jobs which need a deep case, like Vee blocks, parallels and scribing block bases; the quick method serves well for smaller things where wear resistance is the main requirement; the jaws for the four jaw chuck I made for the Unimat were case-hardened in Kasenite. The process is sometimes used to keep costs down, case-hardened mild steel is cheaper than tool steel and for components like drill bushes in the larger sizes, just as good.

There are other ways of case-hardening,

but they involve salt baths and extremely toxic chemicals and are best left to those who do it for a living.

The three main groups of steels I've described so far are what used to be known as 'plain carbon steels', these days they are not quite as plain as they used to be, with small amounts of other elements in them to improve them. There are hundreds of other steels and some are far from being plain iron/carbon mixtures. They are the alloy steels and one in particular is invaluable to use for cutting.

High Speed Steel (HSS)

There are several expensive elements in HSS which give it the properties of heat resistance and toughness. It is also hard and the combination of these allow it to cut at high speed without losing its edge, typical example is one called 18-4-1, which is used for drills and other cutting tools. The figures mean that it has 18% tungsten, 4% chromium and 1% vanadium, a combination which gives it toughness, hard wearing qualities and the resistance to heat which we call 'red-hardness'.

There are many other HSS's and most of them have tungsten or cobalt in them. It makes them expensive but they are well worth the cost. Heat treatment is complex and needs a furnace which will reach 1200 deg. C., so it is another job for the professionals, or a blacksmith with the know-how and a hot forge.

Because of the cost, most HSS's for lathe work are tool bits designed to be held in holders. As the tool bits are from 1/8 in. square upwards, the 3/16 in. and 1/4 in. ones are ideal for small lathe users. For those with larger lathes, butt-welded ones are very good. They have a mild steel shank with a short length of HSS flash butt welded to it. They are pre-shaped in a large number of sizes and shapes and are almost ready for use, just needing a minimum of grinding.

The makers' instructions about grinding HSS tools, whether lathe tools, drills or whatever, will be, 'grind dry on a free-cutting wheel'. In spite of all temptations to stray, it needs following to the letter because an overheated tool plunged into cold water will be stressed.

The effects of the stressing won't be noticed till the finish suddenly spoils, usually in the middle of a cut. It is caused by a small chip coming off the cutting edge, hardly big enough to see, but enough to spoil the finish. Sod's law dictates that it is the finishing cut more often than not. The remedy is to allow the tool to cool from time to time when grinding, and only use water as a last resort. I know that a freecutting wheel is often a myth but frequent dressing helps to keep it in good condition.

Stainless Steel

Stainless is a very important steel for parts which have to resist corrosion. The resistance comes from chromium and nickel which are the main alloying elements. Unfortunately, the corrosion resistance is fine but the machining often far from easy. There is a marked tendency to work-harden and this wears the tools out very quickly. A cutting speed of 40ft./min. and a coarse feed gives good results but the tool must be sharp and well cooled. Stainless gets very hot very quickly and

QUICK TIP

For centre punching when marking out fine work I prefer a slim punch so I can see exactly where the point goes. I use Obo nails, sold quite cheaply in hardware stores. A pack of these about 70mm long and 4mm dia can be ground to different angles for different jobs. They are made from excellent steel and keep their edge. Wrap the shaft in insulating tape to give a good grip.

A. Johnson

(Obo nails are inclined to fracture with dangerous consequences if hit hard. If a substantial indent is required use a conventional centre punch to open up the initial mark - Ed.).

without coolant will rub the lands off drills and the edges off other tools. The swarf is usually razor sharp and coils round everything, so bags of protection is needed and a pair of pliers to pull off the build up of swarf. Don't use your hands to do this.

Rake angles for stainless are between 5 and 10 degrees. When drilling especially, make sure that the drill is freshly ground.

I had a good introduction to the work hardening property of stainless when I had to close a 1/2 in. dia. rivet in a coupling flange. This was when I was an apprentice and I've never forgotten. I began hitting the snap with a 4oz. hammer and the hammer weight increased in proportion to the frustration. I didn't fully close the rivet, even by beating it furiously with the largest hammer I could find. What I should have done, was soften it first, then close it with as few blows as possible with the largest hammer: we live and learn.

For all its awkwardness in some things, stainless has one important virtue, it silver-solders like a dream. There is no oxide film to bother about and the solder runs like water.

There are two metals we use for cutting. Which aren't steels, but I think their place is in with the cutting alloys, that's where they fit.

Stellite

This is an alloy of cobalt, chromium, tungsten and carbon. It looks just like HSS and is available in much the same shapes and sizes. It has slightly better red hardness than HSS and deals well with materials which aren't easy to cut like cast iron and bronze which are heavily scaled and likely to have hard spots. It is more brittle than HSS and is more likely to chip at the cutting edge if it has too much clearance. It is non-magnetic and cannot be softened. It is used for hard-facing and is made in welding rods or as tool bits. If you can use welding equipment or know a welder, get some Stellite deposited on the end of a mild steel rod and it will make a very durable scribe or punch when ground to shape, which can be done on the same wheel as for any other tool made from tool steel.

Carbides

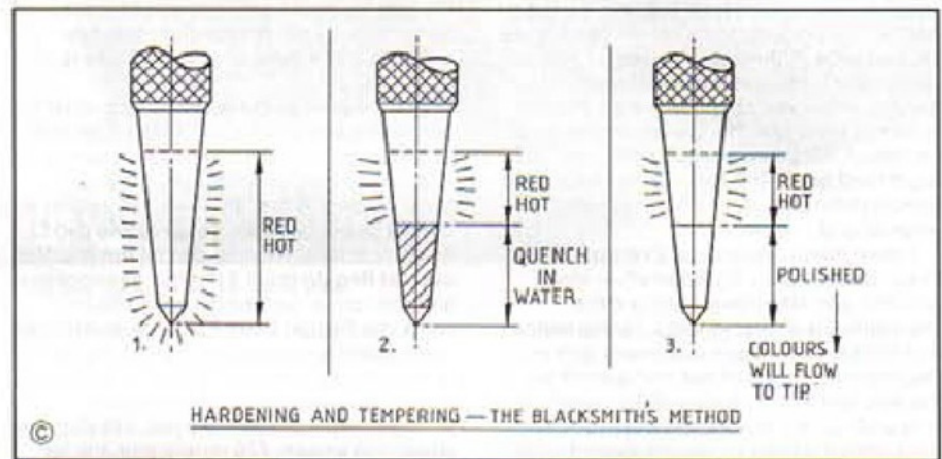
These are made by mixing powdered carbides of various metals with a binder and sintering them. The sintering process means that, after pressing them into the shape wanted, they are heated in a furnace for an hour at 1500 deg.C. The carbides are hard to start with and the sintering makes them into a very hard metal indeed. They are used for the inserts in masonry drills and large saws, tips for brazing to mild steel shanks and 'throw-away' tips of many different shapes and sizes. The throw-away tips are the best for model makers because they are easy to change, can be sharpened, on the right wheel, last a long time between re-grinds or throwing away, and aren't too expensive. They are very good for high speed machining and will double or treble the cutting speed of HSS. They will happily plough through scale, hard spots and other problems which would make other tools wear out. They cost more than other tools and need diamond hones for touching up, green grit wheels for sharpening and bags of support for the rather brittle cutting edge. They are worth the extra expense and the only thing I have

against them is the exorbitant price of the holders.

These can, however, be made. All it needs is a special counter-sunk screw for clamping the tip onto the shank. If you look carefully at the hole in the tip you'll see that the countersink angle is 60 deg. included instead of the normal 90 degree. The best screw to use is a 4BA cap head turned to the 60 deg. angle. The small size of throwaways to fit a 1/4 in. or 6mm holder are the size for small lathes of the Unimat or Toyo type.

Heat Treatment

No discussion of ferrous metals, that is those containing mainly iron, is complete without mentioning heat treatment because it is a magical process in its effects, and the influence of very small amounts of carbon and other additions on the finished job is quite incredible. Incredible that is to the layman, we take it for granted, but I have never lost the sense of wonder that I first felt when I hardened my first job.



Carbon steels above 1% carbon are the ones we use most for making cutters and punches, so most of what follows refers to that. Using simple equipment these steels can be hardened, tempered, softened and normalised as we need, I have a small butane powered gas torch of a type which can be bought in any DIY shop. My hearth is several bricks arranged to reflect the heat and it will get small jobs hot enough to heat treat. I do the heating in the shed or out of doors, well away from anything which will burn. Before I had the torch, the gas cooker used to do the small jobs, anything bigger I had to take to the local college, where I still have good friends.

Given a suitable heat source the only other things needed are, pliers or tongs to pick the hot work up, a container of water for quenching and a quantity of oil for blacking work; I use old sump oil and it seems to work all right.

There are a few things which have to be right to get good results,

Hardening

To get the magic to work, a steel must be hot enough to allow the structural and chemical changes to happen: it must be a high carbon steel as well, or you will be wasting your time. I have lost count of the times when I have heated and quenched a piece of steel and found it still soft afterwards. So check first if there is any

doubt, the spark test on a grinding wheel is the simplest. If there are a lot of fine branching yellow sparks with little star bursts in the branch, the steel will harden.

Colour is the guide to temperature and 'cherry red' the most quoted one. I find this a little bit vague. Some cherries are almost black, some yellow with red streaks. I think the cherry addicts mean the ones used in cakes or fancy drinks. Fine if it gives the right results, but there other ways which are as good or better. My favourite way is to heat the steel till it just begins to scale, easy to see because light patches will appear on the surface. Another way is to use a magnet, because when a steel becomes austenitic, meaning that the transformation is complete, it is non-magnetic. So when a magnet won't stick to the steel it is ready to quench. Of the two, I prefer the scale method.

However the temperature is judged, the job should always be quenched across its minimum section, as shown in the sketch, otherwise it could distort or crack due to uneven cooling. There must be enough of

the cooling water or oil to get rid of the heat quickly; for small parts like a scribe or a small punch, a cupful would do, for larger jobs a bucket would be better. For the cooling, water is usually all right for small jobs and case-hardening, some larger work with wide variations in section would benefit if oil were used to reduce the shock slightly and lessen the risk of cracking. Luckily, silver steel, gauge plate and old files are tolerant of rough and ready heat treatment.

More sophisticated steels are best left alone because the heat treatment can be very complex.

Softening

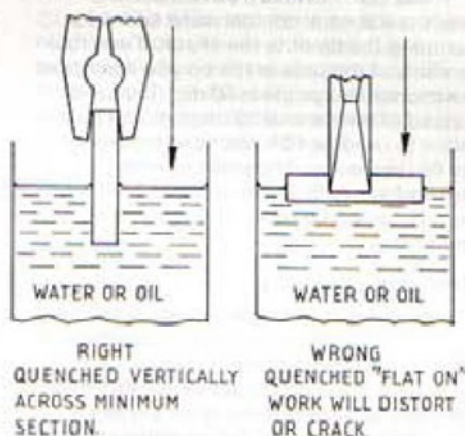
I have called this process softening deliberately, it is just that, a method of making a hardened steel soft enough to do further work. The word annealing refers to the proper process done in an oven, which is why I haven't used it. My softening is done by heating the job to scaling temperature, non-magnetic state, or red heat, depending on your fancy, holding the temperature for a couple of minutes, longer if it is a big job and leaving to cool as slowly as possible. I just leave it in the hot surroundings and take the flame away, leaving it till it is cool enough to handle. It works: correct annealing is done by heating the job in an oven to the right temperature, switching the oven off and leaving the

TEMPERING COLOURS

COLOUR	TEMP (°C)	USED FOR
STRAW	235	SCRAPERS TURNING TOOLS
		'D' BITS COUNTERBORES COUNTERSINKS
BROWN	245	CENTRE PUNCHES SCRIBERS
PURPLE	270	COLD CHISELS
BLUE	300	SPRINGS SCREWDRIVERS

©

QUENCHING



whole lot to cool.

When I was an apprentice, I was lucky to know a skilled blacksmith, who taught me a lot about heat treatment, quite informally because most of the time I was in his shop I had no business to be there. He was known far and wide in the workshop as 'Steamboat'. He was a mine of useful sayings, like, 'you only 'ots the bit you wants to work on'. The sketch shows what he meant. Most tools and cutters only need to be hard on their edge or face, hardness should reduce gradually from the hard edge or end.

I once made Steamboat a centre punch to his specification. It was of silver steel, 1/2in. dia. and 10in. long, such are the requirements of blacksmiths. He hardened and tempered it in one operation, getting the first inch or so red hot and quenching the first half inch in water. He put it into the vice and quickly polished the cold section, then waited while the colours flowed back down from the hot part, quenching for the second time when the tip went brown. He tested it by driving it through a piece of 1/2in. brass plate, using his large hammer.

Steamboat had a way of dealing with awkward tempering jobs where the shape meant that there was a chance of uneven heating. He would heat a piece of steel plate, 6 x 4 x 1/2in. to red heat in the forge, lay it on the concrete floor with a wire grid over it and put the work on the grid. Because the heating was indirect, it was uniform and the work just needed taking off and quenching when the colour was right.

He used the same technique for toasting his sandwiches, except that the wire grid was cleaned first, then placed on the floor with the sandwiches on it and the red hot plate held over them with tongs. He was a genuine character whose experience would have filled several text books.

Tempering

Colour is the key to successful tempering and isn't as subjective as for hardening. I use four colours, straw, brown, purple and blue. Occasionally I will try to find yellow, but it has gone before I can do anything about it more often than not. I know that the text books give more colours, but it is one thing to write it down and quite another when you have a scriber in your hand, the light isn't all it should be, and the colours are running quickly. So I think that four colours are quite enough to

worry about.

The heat source for tempering is a lot gentler than for hardening. If I am using the gas torch, I waft it gently to and fro over the job, if it is the gas cooker, I turn the flame down a bit. A splendid heater for tempering is a Bunsen burner, if one is available.

For tempering, the work surface must be polished and clean because the oxide film is what gives the colour. Finger marks are bad for the film, so keep them off the polished part. If the job needs tempering all over, a gas cooker will go up to 245 deg.C, which is brown. The job can be put into the oven at Regulo mark 9 if it is a gas cooker and the colour wanted is brown. Straw would be Regulo mark 7. Ask permission to use the oven; you wouldn't like it if your wife used your lathe without asking. The other colours are out of the range of domestic equipment. They are, 235 deg. for straw, 245 brown, 270 purple and 300 for blue, to give the complete list.

As most of the tempering jobs we do will be things like punches, tools and items which have to be hard on the end, the best method to use is the one where the colours flow from shank to tip. It is possible to get the colour to start at the right place and stay without quenching, it takes good judgement but it can be done with practice. Tempering in this way gives plenty of control and is much better than trying to get an all over colour. Remember Steamboat's advice, "Only 'ot the bit you wants to work on".

As for what the different colours are used for, straw is for edge tools like turning tools made from carbon tool steel, brown for scribers, centre punches and riveting tools, purple for chisels and blue for screwdrivers.

Normalising

Bright steels have been made bright and accurate by cold drawing or cold rolling. This stresses the outer layer of the metal and gives it a grain like wood, in the rolling or drawing direction. If lumps are cut out of a piece of wrought metal, the uneven stresses left will make it bend or twist. To avoid this the metal needs to be normalised. The process consists of bringing the metal back to what it was before it went through the rollers or dies. The metal is heated to bright red, scaling, or nonmagnetic and allowed to cool slowly, before any machining or shaping is

done. It reverses the stresses and is similar to softening, the only difference is that for normalising, the work can be taken out of its hot surroundings left to cool in still air, which just means that it shouldn't be in a draught.

One last treatment involving heat is bluing. This is a way of giving a steel part a blue or black finish, it looks nice and helps to rust-proof it. The part to be treated is heated to dull red and quenched in oil. It must be oil and the part must not be heated to more than dull red or it may scale and make unsightly patches on the finish. For obvious reasons, don't blue any part which has been hardened and tempered.

The precise specification for steels used to be given in a series of EN numbers. These have been replaced by a new standard based on a six symbol combination of letters and numbers. It isn't really within the scope of a plain man's view of materials, but it won't hurt to give a couple of examples.

080A52 will be a plain carbon spring steel. 080 means that it contains 0.8% manganese, an element present in most steels. A means that the chemical composition is a requirement and is correct. 52 means that the carbon content is 0.52%. Any steel with the number between 000 and 199 is a carbon or carbon-manganese steel. Alloy steels have a number between 500 and 999, an example is, 503M40, 503 means that it is an alloy steel, M means that it has a mechanical property specification, in this case it can be heat treated. 040 means 0.4% carbon. It also has 1% manganese and 1% nickel and would be used for axles and crankshafts, being very tough and strong when heat treated.

So there is a new set of standards to get used to, farewell the EN numbers. Almost farewell that is, because a form of EN number is used by the E.C. These sound a bit complex, what E.C. bureaucracy doesn't? However, for what its worth, here is an EN number used by the E.C. EN 2923 is a standard for, 'Nuts, hexagon plain, reduced height, reduced across flats, in heat resisting steel, silver plated. No comment.

That is a quick and simplified account of the ferrous metals we are most likely to use in model engineering. There are many more, a lot of them very specialised with narrow applications, and outside the scope of a magazine article.

Next time I will go on and discuss some of the non ferrous metals.

QUICK TIP

Very useful small knives can be made in many differing shapes and sizes from worn out hacksaw blades. Produce a suitable length of blade by carefully grinding through the blade at the length required, then, with equal care grind off the teeth along the length. Grind the knife to shape and create the cutting edge, hone the knife on a slip stone to give a sharp edge. Finally add a short length of 10mm rubber tubing to make a handle, 120mm is a good overall length.

Jason Langan

USING A BENCH PRESS **PART 2**

In this, the second part of the series, the use of a bench press for metal bending is explained. Also mentioned very briefly are some additional relatively simple uses, and also some adventurous subjects such as metal drawing

This time the subjects covered in the article are: obtaining and using a bench press, chiefly dealing with using the machine for the bending of plate and strip.

Bending strip and plate

Bending strip or plate on a bench press is a very simple operation, normally done with an item like a vee block on the bed of the press, and the punch with an outside vee formed on its edge. I say normally, as examination of **photographs 15 and 16**, will show the lower part to be just a rectangular slot, and the upper part has an approximation to a vee, formed with a series of steps. The reason for making it in this manner was due to not having a sufficiently large adjustable angle plate, or



The vee (see text) bender in use.

other device, available to deal with this length of item. In both the case of the vee block and the blade, the working edges will require radiuses, these can, with care, be done adequately using a hand file.

Most readers will probably consider that as there will be some spring back when the pressure on the ram is released, the angle of the slot and/or the blade will require to be a little less than 90 degrees. Spring back will occur, if only slightly, so perhaps it is surprising that the vee in the base is normally cut at 90 deg.; however, blades from some suppliers are available with angles of either 90 or 86 degrees.

My own theory as to why this works satisfactorily is shown, albeit exaggerated in **sketch 1**. Is any reader able to confirm my theory, or if it is wrong let us all know why this is the case?

In the case of the arrangement made, the angle bent depends on the extent to which the upper blade is allowed to drop into the vee. The omission of the vee form in favour of a rectangular slot has one disadvantage, fortunately this is fairly easy to overcome. It is essential that the upper blade is both parallel and central to the slot below; with a vee groove this is easy, just bring the blade down into the bottom of the slot prior to tightening its fixing to the press bed. In the case of rectangular tooling, either the blade should be made the same width of the groove, or the blade centralised using two separate pieces of material, one on either side of the blade. If these are thicker than the available gap, they will take up a vee formation as if being bent, this will locate the base centrally to the blade.

Whilst this simple arrangement is adequate for most applications, it will not

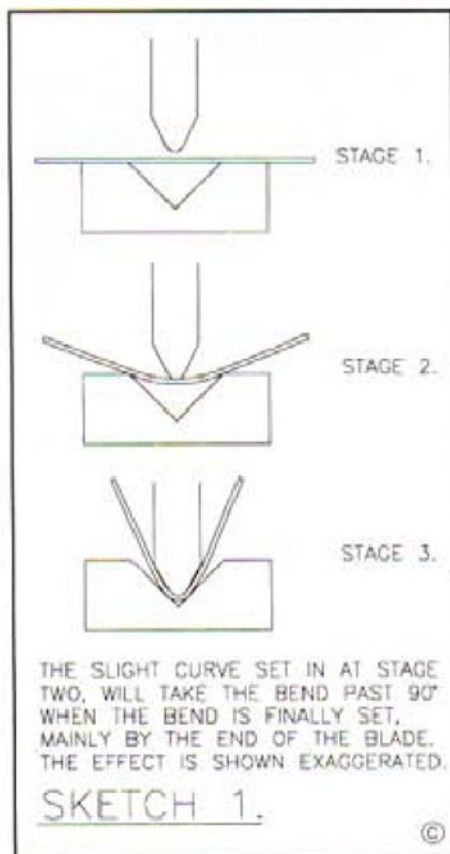
be so if the work being undertaken is to form bends on more than two adjacent sides, such as a tray or a box. In this case, earlier bends will foul the blade when the latter bends are attempted. To overcome this, the blade must be smaller than the inside dimension of the box, necessitating a range of blade lengths.

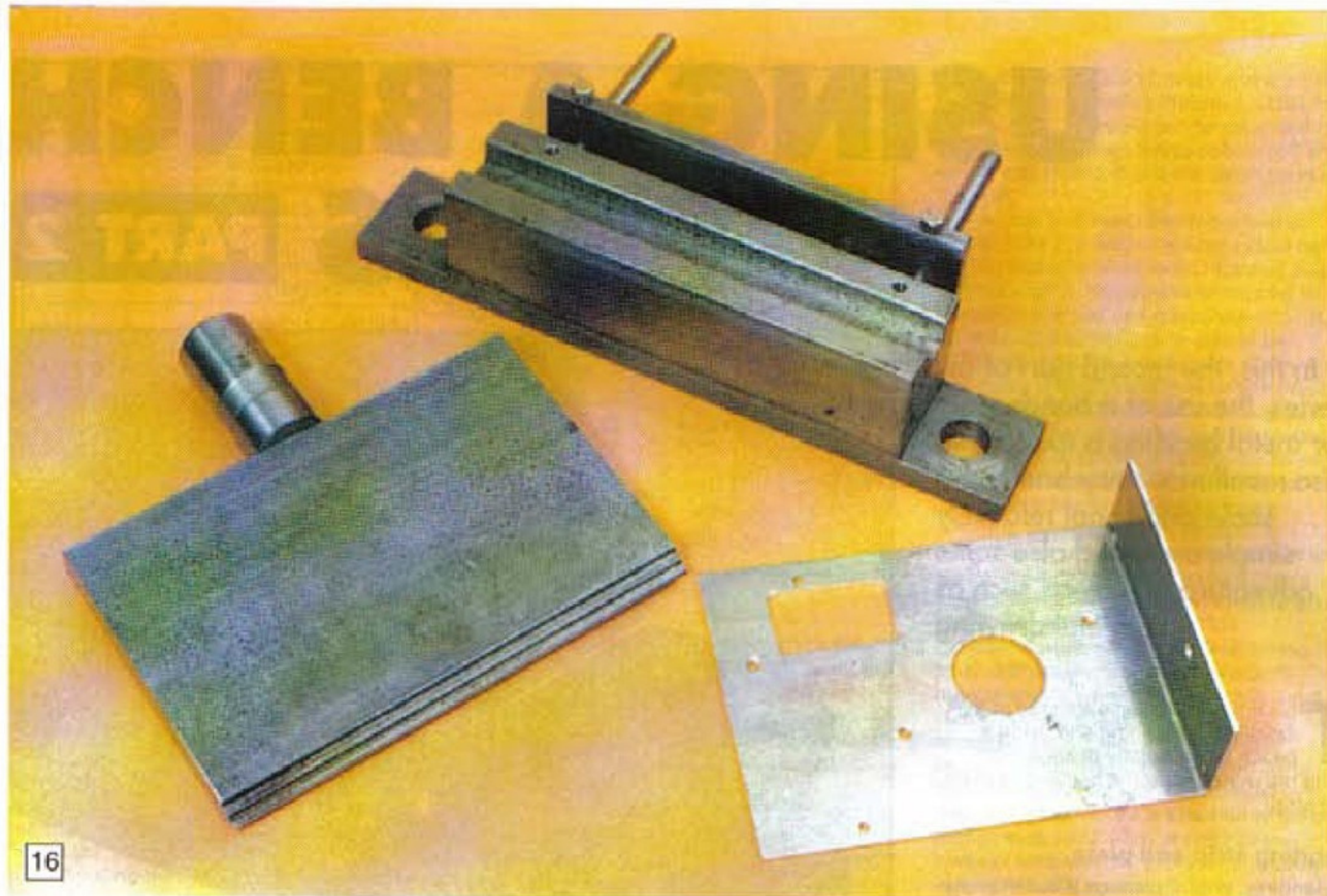
Fortunately, bends can be made perfectly satisfactorily with blades a little shorter than the bend being made, even so this can still create a need for quite a number of blades to be available. This can quite nicely be overcome by the method used in industry on the much larger press brakes, which bend by the same principle. In this case, the upper blade is made up from a range of, differing lengths blades, which, used in various combinations provide a wide range of blade lengths. This can be seen in **photograph 17**, which shows the vee bender supplied by Hunton Engineering.

Bending thicker materials

One other situation will also require variation to the bender already suggested, and that is attempting to bend thicker materials. I consider all readers will appreciate that the thicker the material, the greater must be the radius formed on the edge of the blades. Of course, coupled with this fact will be that the minimum radius possible, will also be dependent on how ductile the material is. Therefore, even for a given material thickness, a smaller radius will be possible on bending grades of aluminium than will be possible on bright mild steel strip. It should also be obvious, that for thicker materials, the vee will require to be wider.

From these facts, it may be considered that this will necessitate a considerable





16

The vee bender with a 100mm x 1.5mm thick plate which was not difficult to bend using the methods described in the article.

increase in the number of accessories required, should the bending of thicker materials be a requirement. However, this is perhaps not so extreme as may appear to be the case, as with thicker materials only narrower items will be bent. Both vee blocks and blades will therefore be quite small, and there will be no requirement for differing length blades. With the ram of the press probably having a hole in the order of 25mm dia. blades 25mm wide could be easily made from a solid length of 25mm dia. BMS. Larger blades say up to 50mm wide may be worth turning from a single piece, in any event, these will not require hardening unless considerable use of these tools is envisaged.

The bender seen in **photographs 15**

Below: The vee bender as supplied by Hunton Engineering.



18

Above: Fitted with a back stop for accurate repetition work.



17

and 16, having a 12mm wide slot and a 1.5mm radius on the punch, will bend 100mm wide bending quality aluminium, 1.5mm thick with complete ease, it has some capacity in hand, an example can be seen in photograph 16. Incidentally the rectangular hole in the plate seen in photograph 16 was produced by the nibbling method described in the last issue. For use in repetition work the rear stop can be seen in use in **photograph 18**.

Whilst when punching holes, the pressure required increases proportionally with material thickness, my limited knowledge of the subject tells me this is not

so when it comes to bending, I consider it probable that for a given width of vee, the increase will be greater than the increase in thickness. However much benefit will be gained by increasing the width of the vee, perhaps quite considerably.

As my knowledge is not that great in this area, perhaps some reader who has had experience in metal bending in industry, may care to expand on the subject, perhaps in a letter or short article.

Even so, with an adequately wide vee block and a punch with a suitable radius, bending items up to 5mm thick and 30mm wide should be feasible, perhaps even more.

Other uses

There are still other uses to which a bench press can be put, I will discuss these only briefly, as they are either simple and require little explanation, or are of limited application in the home workshop.

One application that can beneficially be carried out on a bench press, is the assembly or dismantling, under pressure, of such items as bearings or dowel pins. There is a word of warning here; the initial fit between the components to be forced together must be correct for the application. If not, due to the quite high pressure available, components that have too great an interference fit, may still be able to be forced together, but with potentially damaging results.

Very little in the way of special equipment will be required for this application, at the most perhaps a special punch and/or anvil, and even these are

unlikely to require hardening.

Riveting is another process that can be carried out on the bench press, and will be worthwhile if there is a large number of small rivets, or even a few very large ones. Special hardened punches and maybe anvils will be required to be made, unless the rivets are being set into countersunk holes, in which case a normal punch used for punching holes will suffice providing it is sufficiently large. Maybe non hardened punches and anvils will suffice for softer rivets, such as those in copper or aluminium.

Metal drawing will also be possible, this is however a very specialized task and anyone having the need, and the determination, should certainly consider making use of the process. It should only be considered for saucer shaped items or, at the very most, very shallow cups. It is not really a subject that can be covered in detail in this article, but again, if any reader has had experience of this process in the home workshop, and can send in some thoughts on the subject, these will be most welcome. Any reader inexperienced in press work and wishing to give it a try should seek out a book on the subject.

The forming of shapes in metal strip is in effect a variation on metal drawing. If a number of not too complex items, preferably all shallow bends, are to be made, then making a die and a punch to shape this at one go would be an interesting exercise. Due to spring back, it may be necessary to make more than one attempt to get the correct shape, and if the shape is critical this is unlikely to be the way to proceed.

Obviously if there are many similar items to be made, and you have more than your fair share of patience, then this could well be a good way to proceed. For small quantities it is unlikely that hardening of either the punch or die will be a requirement.

Next time we will conclude with some instruction on operating a bench press, also some data on making punches and dies. A little experimentation in using a bench press, still to be carried out will be explained and the findings reviewed.

QUICK TIP

To grip small washers or discs in the three jaw so that they run true for boring or enlarging or whatever, place the washer across the poles of a magnet - some of the ones you can recover from old coin operated electricity meters, found at boot sales, are ideal but any horseshoe magnet will do. The magnet and washer are then presented to the chuck and the assembly will adhere to the jaw faces, whereupon the chuck is tightened and the magnet slipped off. If you want the washer to protrude for facing place a thin strip of metal either side of the washer before presenting it to the chuck - the work will protrude by an amount equal to the thickness of the strips.

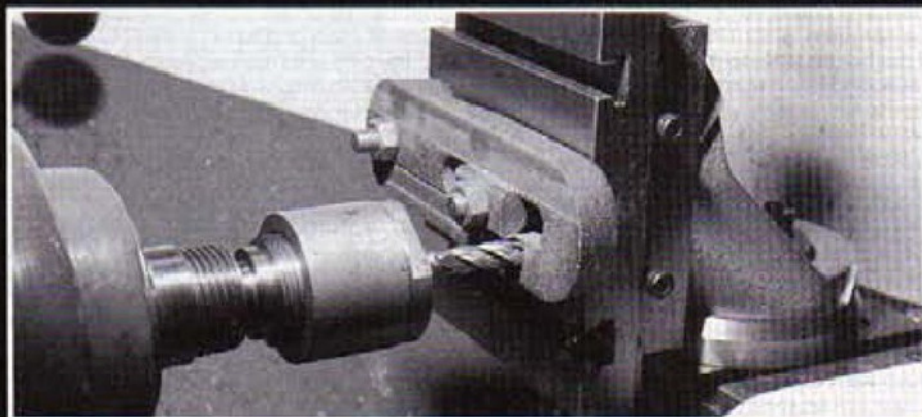
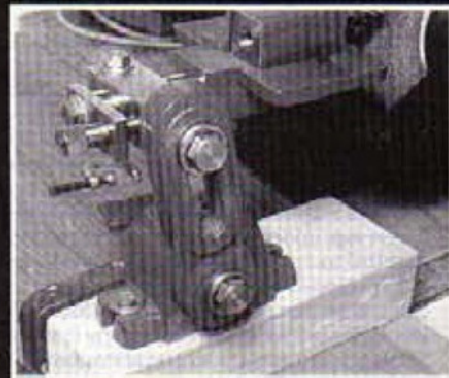
J.M. Service

IN OUR NEXT ISSUE!

Contents may be changed

**Coming up in the
JANUARY/FEBRUARY
issue No. 21 will be:**

**Making the Hart Grinding
Rest. This is seen being made
with the milling operations
being carried out on the lathe.
It will therefore be of
considerable interest to those
who carry out milling by this
method.**



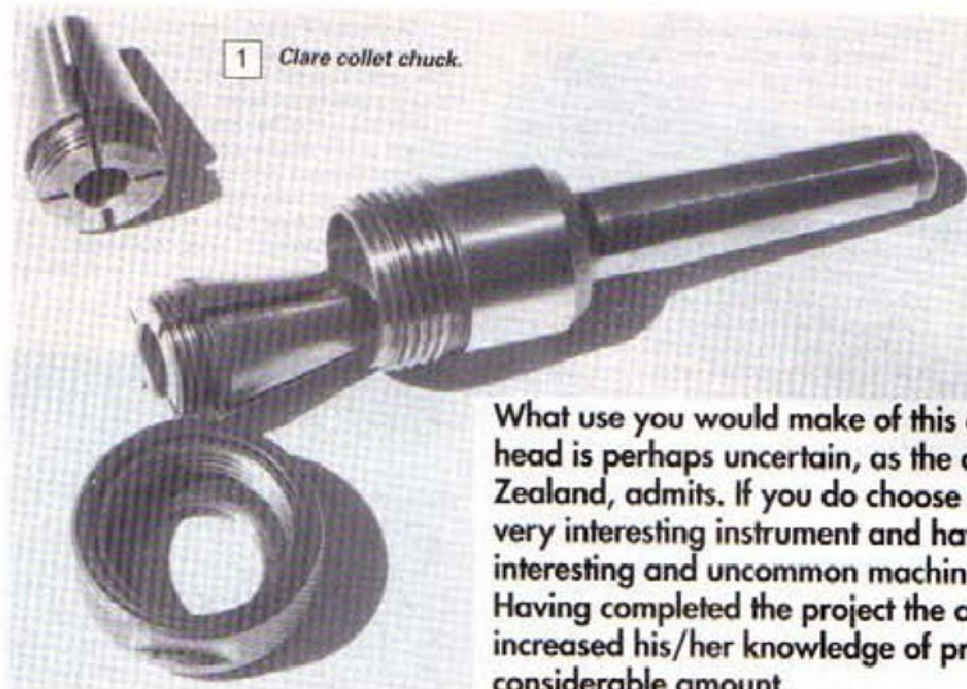
**A horizontal milling
attachment for use on the
lathe.**

**We list some British
Standards of interest to the
home workshop owner.
Indicating where to go for the
official view on such subjects
as - materials, steel, brass
etc. - tools, taps, dies etc. and
other workshop related items,**

**ear defenders, safety glasses,
drawing standards etc.**

**We review a number of
economy CAD software
packages, and come up with
three worth considering.**

**AND MUCH MORE
Issue on sale
24 December 1993**



1 Clare collet chuck.

**FREE
PULL OUT
PLAN**

What use you would make of this differential screw micrometer head is perhaps uncertain, as the author Bill Morris, in New Zealand, admits. If you do choose to make it you will possess a very interesting instrument and have carried out some very interesting and uncommon machining operations. Having completed the project the average reader is likely to have increased his/her knowledge of precision turning procedures by a considerable amount.

A DIFFERENTIAL SCREW MICROMETER HEAD

In the October/November 1991 issue of *M.E.W.* Gordon Lewis described how to make a collet chuck using Clare collets. The size likely to be used by amateurs is their size A. These have a 70 deg. included angle and a Whitworth form thread of 16 TPI. The nut used to force the collet into its holder has a matching 16 TPI thread for the collet and one of larger diameter and coarser pitch, of 12 TPI to engage the nose of the holder (**Photo 1**). There seems to be a misconception that this difference of pitch is essential to jack out the collet. In fact, with an included angle of 70 deg., if a collet did get stuck in the holder, a gentle tap would let it drop out. I have tried various ways of making the collet stick and in practice it simply does not happen. The purpose of the difference is to force the collet into the holder. One turn will advance the nut 0.8 inch. However, provided the collet does not rotate the nut will have advanced 0.063 in. on it, so that the net movement of the collet relative to the holder will be the difference, only 0.02 inch. Effectively, the combination behaves as a thread of 50 TPI, without the weakness of such a fine thread, and the collet gets pushed in with a correspondingly greater force.

Pondering on all this led me to consider where else such an ingenious but simple mechanism for increasing mechanical advantage and velocity ratio might be used. Its major use seems to have been in machine slides to obtain very fine feeds or adjustments of parts relative to one another. I was fascinated to discover that the principle had been used by the National Physical Laboratory in a micrometer mechanism. In order to illustrate the mechanism to readers, I decided to try to

make one of a similar pattern. At that time I had no idea what I might do with it when I had finished. I ended up with a micrometer head, able to differentiate to a precision of one micro-metre (0.001 mm). This is graduated in units of one micron, or about one seventh the diameter of a red blood cell. (*Obviously a medical man - Ed.*) The graduations on the thimble are about 1.25mm apart and easy to read.

I have no idea how accurate it might be as I have no means of measuring to the required limits. It did not require more than ordinary care to produce, and should not be too difficult for anyone of moderate experience to reproduce; provided their lathe is in good condition and properly adjusted. Concentricity of most of the parts is very important, as is accuracy in manufacture. Some of the machining set-ups look shaky for this reason. Fit is also important, but anyone capable of making a model piston fit in a cylinder should be able to manage. In some areas, finish is important to minimise wear, with consequent loss of fit and concentricity.

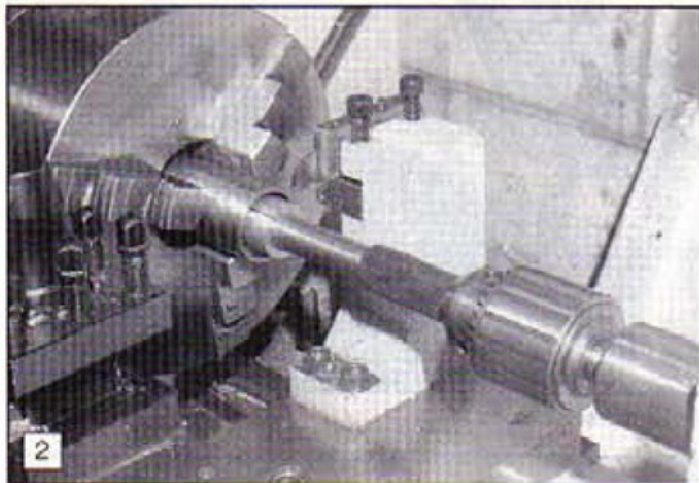
With a conventional micrometer head, it is essential that the face of the spindle anvil is flat to within less than a micron and square with the axis of rotation. The plunger of the differential head does not rotate, but squareness and flatness are nevertheless important. Unless you can lap the anvil flat to within a micron and at right angles to the axis of the spindle, you will end up with an interesting curiosity that illustrates a principle, rather than a useful instrument.

Since not everyone may wish to follow my dimensions slavishly a discussion of the design parameters may be useful (**Figure 1**).

The mathematics

Consider a screw with a coarse threaded portion of pitch P_c followed by a finer threaded portion of pitch P_f . The coarse portion engages a fixed nut of length F and the fine portion engages in a nut which can move axially but not rotate, of length M . For each turn of the screw, it will move to the left for a distance of P_c , but the moving nut will move on the screw, to the right a distance of P_f , so that the moving nut will have a net movement to the left of $P_c - P_f$. If the moving nut is to have a total movement to the left of d , then $d/P_c - P_f$ turns of the screw will be needed. For this number of turns of the screw, the coarse pitch part will move through its nut a distance of $(d \times P_c)/P_c - P_f$, so the minimum length of the coarse thread will be, $F + (d \times P_c)/P_c - P_f$. Similarly, the minimum length of the fine thread will be $M + (d \times P_f)/P_c - P_f$. Finally, if both parts are of the calculated minimum lengths, the maximum distance between the fixed and moving nuts will be $(d \times P_c)/P_c - P_f$ and the minimum distance will be $(d \times P_f)/P_c - P_f$.

Since I now try to keep things metric in my workshop I decided to aim for a difference in pitch of 0.1 mm with pitches of reasonable fineness so that cutting forces on a necessarily slender screw would be kept to a minimum. At the same time, the finer the pitch, the easier it is to damage the threads and any errors of fit become proportionally greater. It had to be possible to cut the desired threads on my lathe; I settled for pitches of 0.9 mm and 0.8 mm, so that one turn of the thimble would advance the moving nut by 0.1 mm. Those locked into the Imperial system might choose 20 and 25 TPI which will give a pitch difference of 0.01 inch. Although not



Internally lapping barrel.

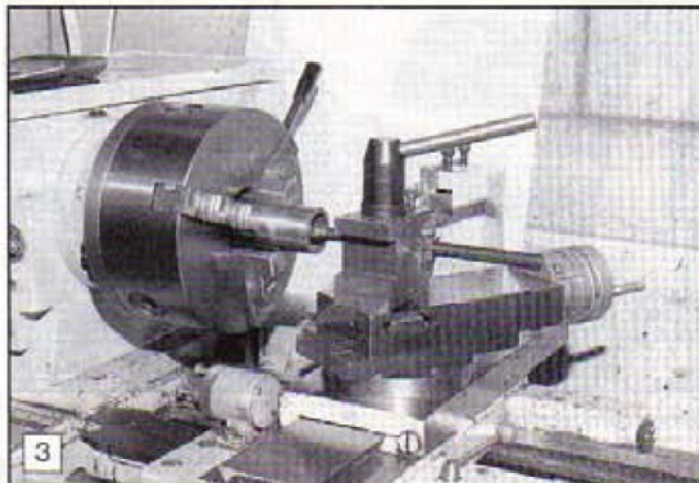
essential, it makes assembly much easier if the outside diameter of the screw that engages with the moving nut is less than the core diameter of that engaging with the fixed nut. The diameters chosen will also depend on the size of the smallest internal threading tool that you can make accurately or afford to buy. The length of my plunger is greater than it need have been, but it still needs to accommodate the full length of the fine screw and the stem of the anvil. The whole head could be made of free cutting mild steel (FCMS), except for the key and the anvil, which should be of hardened silver steel. I had to make do with something tougher than FCMS for the barrel and thimble because I had nothing else in the size needed.

Barrel

The barrel (Item 1) seems to be a good place to start since it has a lot of internal machining. I find that it is easier to make a shaft to fit a hole than vice-versa. Chuck a piece of 38 mm dia. MS with at least 95 mm projecting, face the end. Centre drill and support with the tailstock centre prior to rough turning to within 0.1 mm of the finished dimension. Part off. At this stage, if you wish to lap the 27.00 mm bore, you will have to pause and make a lap as in Fig. 2.

Re-chuck with the minimum length projecting and, if your lathe is a small one or the chuck cannot accommodate 38 mm through its centre, support the outboard end in a fixed steady. Next drill right through about 18 mm and bore to the finished dimensions. They do not have to be exactly the ones I have shown, but when a dimension is given to two decimal places, it implies a very close fit with its mating part. I will indicate the sort of fit as those parts are described.

The rather strange choice of thread of 28.5 mm by 32 TPI to receive the guide is for two reasons. Its core diameter of 27.47 mm gives clearance for the plunger; and my lathe has everything metric except for the leadscrew and chasing dial so it is easier to cut Imperial threads on it, especially those which have no run out. Try to get the finest finish you can on the internal dimensions. Although the 19.50 mm hole for the coarse nut is at the bottom of a deep dark hole and therefore difficult to measure, try to do it at this stage to ensure concentricity of the nut it is going to receive. Its absolute size is unimportant since you are going to make the nut to fit.



Screw cutting the nose of the barrel.

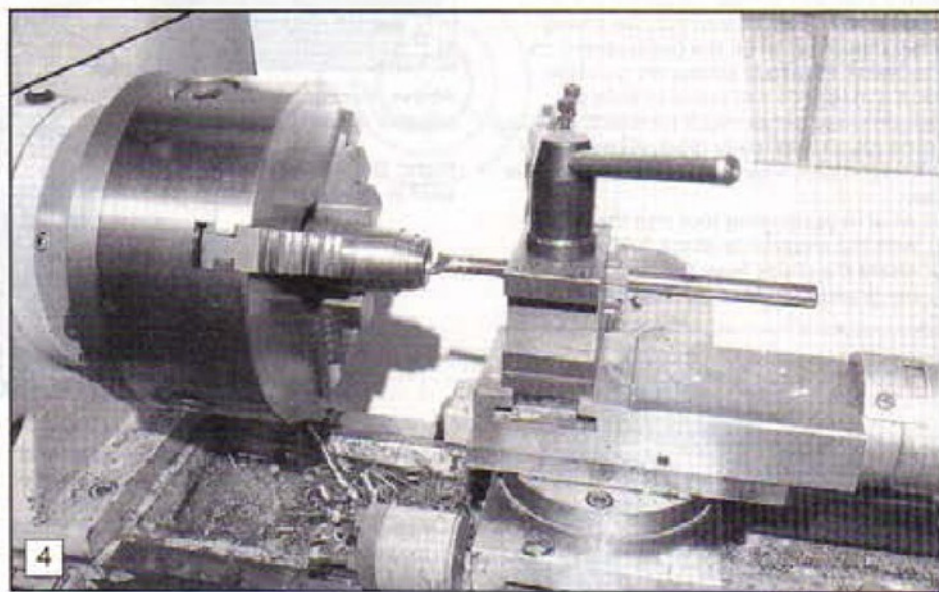
Take a fine finishing cut over the outside of the nose of the barrel and face the shoulder square at this stage, as these are locating surfaces which have to be parallel and square respectively to the bore.

Free cutting mild steel when attacked with a very sharp and well-honed tool can be given an extremely fine finish. If you are going to lap the 27.00 mm bore, now is the time to do it (Photo 2), and the better the turned finish, the less lapping there will be to do. The lap is best held in the tailstock, with an intermediate flexible coupling provided by a piece of rubber hose as

a fine finishing cut as it is a locating surface. Reverse in the chuck, face the other end and cut a fine chamfer on the 19.50 mm bore. Finishing the outside comes later.

Guide

The guide comes next (Item 2). If you wish to lap the bore, now is the time to turn down the lap you made for the barrel (and will probably otherwise never use again). Start by chucking a suitable piece of 35 mm

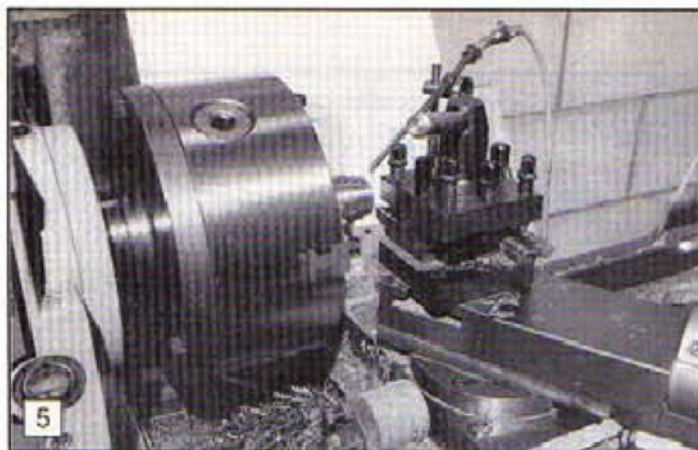


Boring guide.

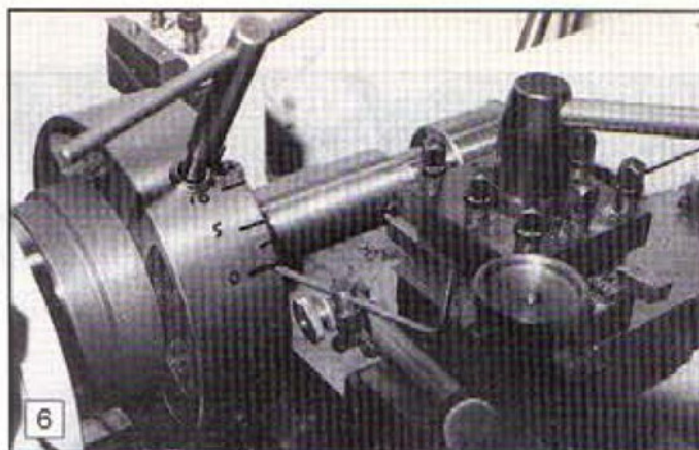
shown. Take care not to allow the lap to dwell at any point and do just sufficient lapping to remove tool marks. In principle at least, lapping is capable of reducing slight errors of roundness and parallelism as well as providing a better wearing surface.

Photo 3 shows the set up for cutting the internal thread and you will see that the top slide is set over towards the of the lathe. Although it would be safer for the inexperienced to cut a groove for the tool to run into, it is a short fine thread and I find that it is quite easy to judge when to snap open the half-nut and simultaneously wind in the cross slide. For 60 deg. thread form, the depth of thread is 0.52 mm and the infeed for the top slide is thus $0.52/\cos 30 \text{ deg.} = 0.60 \text{ mm}$. The face between the plain and threaded portions should receive

material. Face and drill 18 mm to a depth of about 15 mm and then bore to 19.00 mm diameter, getting the finest finish you can manage (Photo 4). Lap the bore at this stage if you wish. Then carefully turn the outside diameter to a close sliding fit in the nose of the barrel before turning down to 28.5 mm over a 6 mm length and screw cutting to fit the thread in the barrel (Photo 5). Carefully finish the face of the shoulder as this is a locating surface. You now have a nearly finished part looking like a small lathe spindle nose, this will be used as a jig for finishing the barrel; so clean the thread with an old tooth brush, wipe off any dirt, apply a few drops of oil and screw on the barrel until the locating surfaces meet sweetly. Bring up the tailstock to support the outer end and you are ready to finish the barrel.



Screw cutting guide.



Dividing barrel.

A digression

A digression is perhaps worthwhile here. If your tailstock and its contained centre is not in perfect alignment, it is quite capable of deflecting even a substantial part like the barrel. Nipping a ruler between the centre points is at best a rough and ready method of aligning them. It depends on the points being sharp, and concentric with the bits of the centres that actually bear on the work. It is much better to make and keep a parallel test bar which can be placed between centres to check alignment with a dial test indicator or a trial cut.

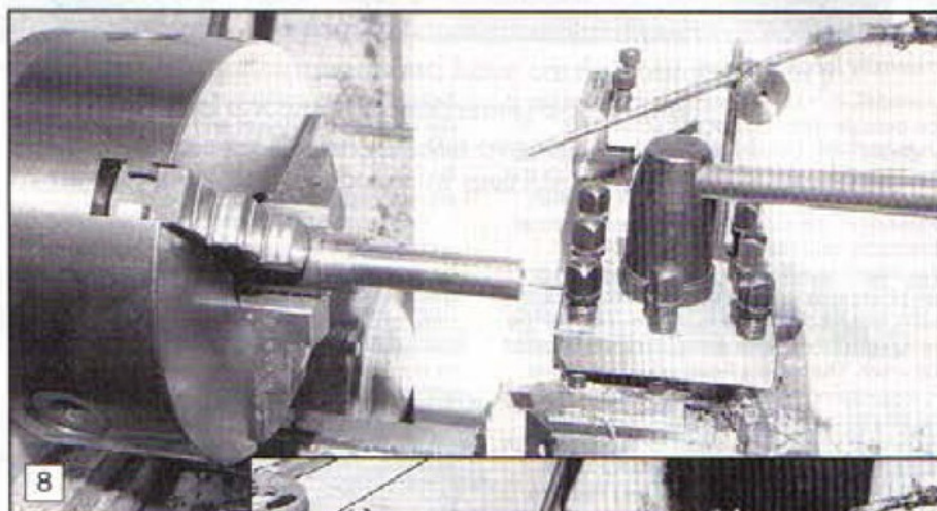
The barrel can now be finish turned and, if you wish, finished with some fine, well oiled emery cloth or given a light touch with a tool post grinder (a Quorn grinding head in my case). I could not, for a long time, think how to do the graduations on the barrel. **Photo 6** shows my solution. I used a magnetic d.t.i. stand to hold a pointer close to the chuck on which I made some rough and ready graduations with a felt tipped pen. The graduating sequence is then

- wind in graduating tool into the work with the cross slide about 0.06 mm;
- rotate the chuck from the zero mark to the graduation mark on the chuck;

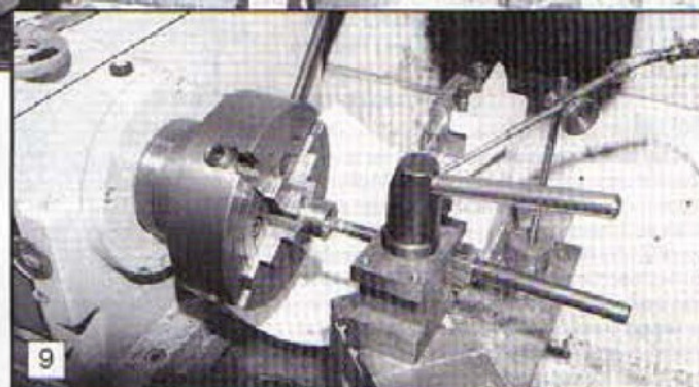


Exploded view of head with pin spanner.

- withdraw the tool clear of the barrel;
- restore the chuck to the zero mark;
- wind the top slide along 0.9mm;
- wind the tool into the work, repeat for sixty times without losing count of where the longer graduations every five and ten marks are to be placed. The graduations start 3 mm from the thimble end of the barrel. Finish off by turning the tool through 90deg. and making a single longitudinal line along the base of the graduations. It sounds rough and ready but gives clear graduations that look quite even. While doing all this it is wise to unplug the lathe or remove its fuse and hang a big notice on the switch



Above: Boring plunger for anvil.



Right: Boring nut-seat in plunger.

saying "REMOVE KEY!" The barrel can now be removed from the lathe and any burrs removed with a fine Swiss file. Which direction you have the numbers rising will depend on what you are going to do with the head.

Back to the guide. This is parted off, the 1.5 mm spanner holes drilled in the front face and a cross hole drilled and tapped M3 for the key. The barrel can then be held in a chuck with soft packing under the jaws, the guide screwed home and its face finished. It cannot be removed from the barrel unless you have first made the spanner holes and have a suitable spanner. The exploded view of the finished head (**Photo 7**) shows a suitable adjustable spanner which can be made in about forty minutes.

Plunger

In making the plunger (Item 3), it is extremely important that the axis of the hole for the anvil is parallel with the outside diameters, to ensure that the face of the anvil is square to the movement of the plunger. Start by chucking a piece of 30 mm steel with about 90 mm projecting,

face the end and centre drill. Then turn the top slide through 30 deg. and with a tiny boring tool take a skim over the centre hole to ensure that it is absolutely on centre, since even centre drills can get deflected. Rough turn to size and then take fine finishing cuts over the smaller diameter without tailstock support until it will just enter the bore of the guide with resistance. It will have a slight taper on it, because the free end will have been deflected more than the end nearest the chuck, so the guide should not go on very far. Finishing of this surface comes later, as a lap has to be made to suit. Now finish turn the larger outside diameter until it is a stiff push fit in the bore of the barrel. Once again it will be necessary to make to suit this job, this can be left till later.

Drill a 7.5 mm hole for the anvil and using a tiny boring tool (**Photo 8**), open out to 8 mm, chamfering the bore to ensure that the shoulder of the anvil will contact the face.

Rechuck in a four jaw chuck, with soft packing around the finished surface, face, drill 12.5 mm x 52 mm deep and bore out to the finished diameters (**Photo 9**). You now have to make two ring laps to finish



10 External ring lap in die stock.

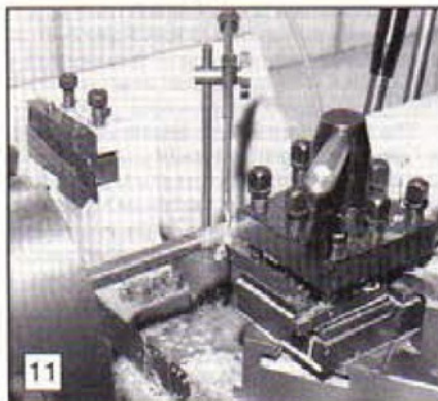
the outside diameters (Photo 10). These are best made from 25 mm lengths of round aluminium bar of an outside diameter which will fit your die stock. Aluminium seems to work just as well as copper and is much cheaper. Drill and bore out the pieces of bar until they are sliding fits on the diameters to be lapped and with a hacksaw make three radial slits from the outside, one of which should go through to the bore. Remove any burrs and then fit the blank into your diestock with a screw bearing on the through slot. You should find that the bore has closed up so that the lap will no longer fit over the diameters to be finished, but the screw can be used to open it up.

Chuck a scrap of steel about 25 mm diameter and turn down a stepped plug to be a light push fit in the 15 and 20 mm bores. Then smear a mixture of light oil and fine grinding powder on the inside of the lap and wheedle it over the 19.00 mm diameter of the plunger, opening out the bore of the lap until it will rotate with a little resistance on the nut end. This ought to be slightly larger in diameter than the anvil end. Push the plunger onto the plug just made, bring up a running centre to apply a light pressure to the other end and run the lathe at about 100 rpm, all the time running the lap up and down the plunger without dwelling on any one spot. Go very gently, removing the workpiece frequently to clean thoroughly with paraffin or white spirit to try for fit on the guide. The aim is to lap it parallel and smooth so that it slides without any shake over the working part, i.e. the half nearest the nut end. Remember that in the lapping process as in most others, there is no such thing as a putting on tool. I found half a minute with the finest grit sufficient. Do likewise with the nut end of the plunger until it fits nicely in the bore of the barrel. I suggest that you roll up your sleeves and remove watch and rings first as you will be moving your hands close to the chuck jaws. Finally, cut the key way with a slot drill either in a vertical milling machine or on the lathe's vertical slide. It is most important that this keyway is both straight and parallel to the axis of the plunger as the latter will otherwise rotate slightly as it extends and cause both progressive and random errors.

Screw

The screw (Item 4) can be made by turning down a piece of 30 mm bar to finished size, which is wasteful, or by building it up as I did. I chucked a short piece of 30 mm steel, drilled it $\frac{1}{16}$ in. (12.7 mm) and used Loctite to marry it to a 130 mm length of $\frac{1}{16}$ in. FCMS. I left this overnight to cure properly before lightly facing the end, centre drilling and bringing up the tail centre for support. While it could

be turned and screwcut between centres, this would be equivalent to a beam supported at both ends and the maximum deflection would be proportional to $\text{length}^3/48$, as opposed to being held in the chuck and supported at one end, when the maximum deflection is proportional to $\text{length}^3/102$, i.e. less than half the maximum deflection than when held between centres. The rest is straightforward turning and screw cutting (Photo 11), taking light cuts because the



11 Cutting the screw.

workpiece is a relatively slender one and difficult to support. There is hardly room for a travelling steady, but in the event, after I had made the nuts, I found that they seemed to fit uniformly along the whole lengths. When screwcutting is complete, part off to length. Chuck by the 12.5 mm section in the four jaw chuck with soft aluminium packing under the jaws and finish the thimble end to size.

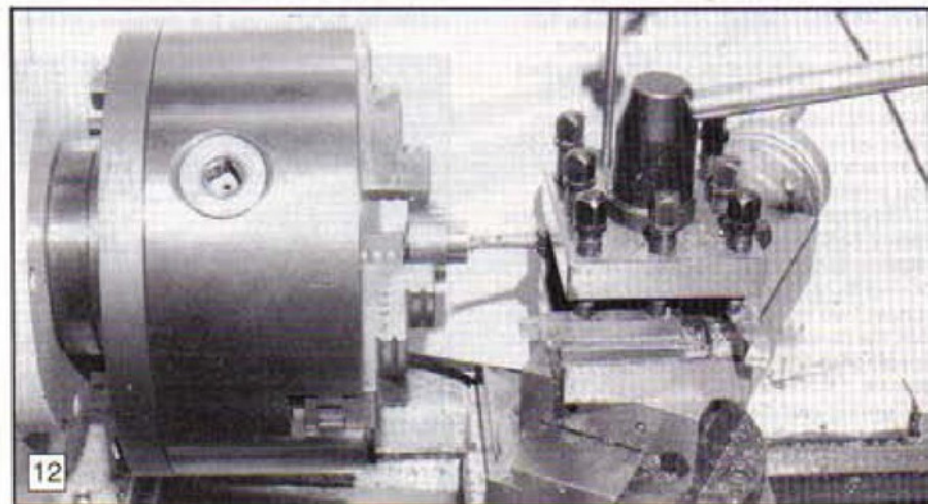
Nuts

The nuts (Items 6 & 7) come next and can be made of steel or brass. I made one

of each. There didn't seem to be much difference between the two in ease of working and only time will tell which combination wears best, though no doubt there are people out there who can tell me. The outside dimensions are simple turning. The core diameters of the threads are shown on the drawing of the screw, but many workers may have difficulty in measuring such small internal diameters and may prefer first to make up a pair of simple plug gauges of 10.02 mm and 11.40 mm diameter before boring to size. Having bored to core diameter, undercut a recess for the tool to run into at just under full length, so that when the nut is parted off no burrs are raised on the thread. As for screwcutting the nose of the barrel, the top slide is set over to the rear at 60 deg. to the axis of the lathe (Photo 12) and cutting continues until the corresponding part of the screw enters smoothly. The fit does not have to be tight, as the nuts are preloaded by a spring. The 37 mm flange of the barrel nut is probably larger than necessary and many workers would quail at having to part off at that diameter. It was there in case the nut needed to be held in place with a couple of screws, but I ended up with a light press fit. In any case, it could, like the plunger nut, be held with Loctite, so if you want to make the flange smaller, by all means do so.

Thimble

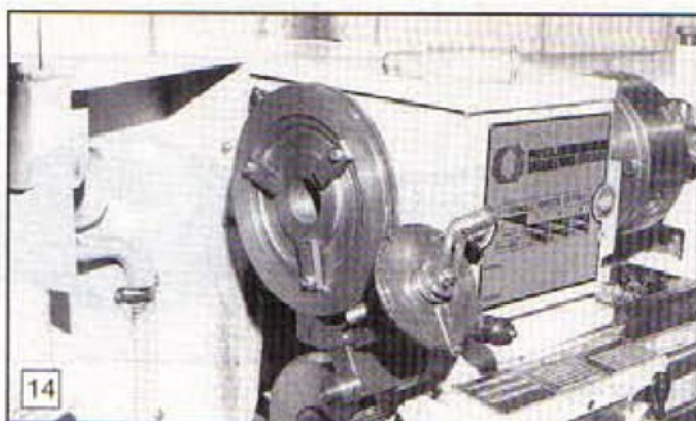
Next is the thimble (Item 8) though for something so hefty thimble is not perhaps the right word. If you have a piece of thick walled tubing of suitable size it could be used to build up a blank; but I didn't so had to make it from the solid. To avoid having yet another stub of material for the scrap box, I chucked a length of $1\frac{1}{2}$ in. bar, faced and centre drilled the end and turned it down to 42 mm with support from the tail centre. I then fine knurled the full length before finish turning the parallel portion. This was then used as a seat for the fixed steady pads for the heavy drilling and boring necessary to reduce the bar mainly to swarf (Photo 13). The bore is fine finished to a nice sliding fit over the barrel and then undercut by about 0.1 mm overall, apart from the first 10 mm; this is to reduce friction. The top slide is then set over 5 deg. to produce the taper for the graduations, being careful not to produce a knife edge which would break down when cutting the graduations.



12 Screw cutting barrel nut.



13
Rough boring thimble.



14
Headstock dividing device.



15
Dividing thimble.

There are no doubt many ways of dividing the thimble. **Photos 14 and 15** show how I managed. Some years ago I made a 359 tooth worm wheel to drive an astronomical telescope for my younger daughter and I had anticipated making a mess of the first attempt so had asked the local foundry to make me two phosphor-bronze castings. As the first attempt was successful, I used the spare casting, mounted on a cast iron hub, to make a 360 tooth worm wheel. This screws on to the outside of the tail end of the spindle and is driven by a crude but effective worm drive which I made hurriedly one afternoon. Readers will recognise that I have used parts of my George Thomas dividing head to save time. When dividing, it is best to plod deliberately on, or before you know where you are you forget to move the sector arms and cut a division in the wrong place or make it too long. I did so on two occasions, but fortunately these are hard to spot. The thimble will accommodate 100 divisions comfortably and if you have made your pitch difference 0.01 inch then each division will represent 0.0001 inch. Mine represent one micron or 0.001mm. Once again, which direction you have the numbers rising will depend on what use you intend to make of the head.

The thimble can then be cut off from the parent bar, held in the 4 jaw chuck with soft packing and the end faced to size before boring the end out to a close fit on the screw. Two holes are then spotted through into the screw flange at tapping size before opening up and countersinking for M3 screws.

Turning and threading the key (Fig 5) out of silver steel poses no problems but the plain portion must be a close fit in the key way as no rotation of the plunger is permissible. Harden the unthreaded portion and temper to dark straw.

Final assembly poses no terrors. I have not shown a drawing for the spring as it will depend to some extent on what you have in the junk box. The only requirements are that it exerts a light preload and fits into the annular gap. The nuts can be pressed into place, Loctited or secured with some 6BA screws, depending on how well they fit. Once the key is in place insinuate a drop of nail varnish or candle wax on top of it to lock it semi-permanently.

Anvil

The anvil (Item 5) also appears to be a simple turning problem until you reflect that the face of the anvil has to be both flat and square to the axis. Fortunately, squareness is not quite so important as in a standard micrometer as the plunger does not rotate, but the method of generating the flat surface will necessarily make it square, at least in theory. Facing the anvil is of necessity a second operation, though if one makes it of uniform section instead of as drawn (on reflection, a much better idea), getting it square is no problem. However, even the best lathe is unlikely to make it flat to the limits required and is more likely to make it concave. I experimented with lapping the end, but ended with a convex surface when tested against an optical flat. Relating my partially successful experiment may be of interest to others.

Spot grinding

A few words first about spot grinding. This is a process in which the grinding wheel of a surface grinder (or Quorn grinding head attached to a mill-drill in my case) is trued from a small surface plate by moving the diamond held in a wide based holder by hand across the periphery of the

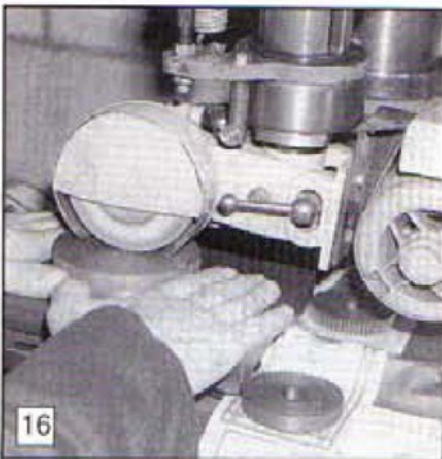
wheel. A very light cut is put on and the workpiece moved about by hand in a more-or-less random fashion between the wheel and the surface plate until all sparking has ceased, taking all the usual precautions for hand grinding, including wearing safety glasses and keeping the fingers straight as shown in **Photo 16**. In common with most machine tool operations, spot grinding can be dangerous if improperly carried out. Proper eye protection must be worn. This means polycarbonate glasses or goggles which fully enclose the eyes. Ordinary spectacles, even those with toughened or plastic lenses, are not adequate, since grit can find its way around the sides. One should not stand in line with the wheel, which must be guarded so that only the part of the periphery in contact with the work is exposed. The height of the workpiece should not exceed its length, especially for small pieces; and the latter are best manipulated by enclosing in a loose wire ring rather than trying to use the fingers in a very confined space.



17
Finish of spot ground surface and jig for spot grinding anvil.

Newspaper is used to keep grit out of the slides and the photo shows the only known use for gears that went wrong! When the other side is treated similarly you end up with the surface looking like that of the lap shown in **Photo 17**. Although the surfaces look rough, they are probably the flattest and most parallel surfaces that most amateurs are ever likely to produce, since any errors in the table slides are eliminated.

The anvil should be heated to bright cherry red, as viewed in subdued light, (get the shadow of your body between the light source and the job) and quenched in water to leave it glass hard. To lap it, one first needs a little jig as shown on the right in **Photo 17**. It is simply a short stub of steel faced on the end and bored out so that the anvil is a close fit in the bore. This end is marked with a felt tipped pen before



16
Spot grinding lap.



Spot grinding anvil in jig.

parting off and facing the other end. The marked end is used as the datum surface in contact with the surface plate and the other end is spot ground to bring it into a plane parallel with it. The stub is then reversed end for end and the bore is then necessarily at right angles to the base. The anvil is inserted into the bore and its face spot ground (Photo 18).

This is probably as far as most people would want to go, except perhaps for a few careful strokes on a lap with some fine grinding paste to remove the traces of spot grinding. However, the face of the anvil can in principle be got flatter.



Rotary lapping.

Lapping

Photo 19 shows the principle as developed by the National Physical Laboratory for lapping the ends of length bars square and flat, though the practice is a good deal more sophisticated. The anvil is held in a chuck (a collet chuck would be truer than a drill chuck) over a cast iron lap which slides on the surface plate which was used to produce it. The anvil rotates at slow speed while the lap charged with lapping compound is rotated in random circles underneath it, applying down feed until a little drag can be felt. I used successively, well oiled 400 grit emery paper, Brasso and, for polishing, some Cerium oxide powder suspended in water, donated by an amateur astronomer friend who specialises in making optics. The aim is to get straight parallel interference bands or fringes when tested against an optical flat. The face of a Porro prism from an old pair of binoculars is flat to the required standard (Photo 20). I got four circular fringes which moved around as I varied the



Porro prism used as small optical flat.

pressure, indicating slight convexity (Fig 10). Since each fringe represents half a wavelength of light and the average wavelength of daylight is about 0.5 micron, the centre was thus about one micron higher than the periphery. Tested against a surface plate with marking blue, this convexity was of course undetectable and there may well be many elderly and worn micrometer anvils about which are a good deal worse though probably in the direction of concavity for the fixed anvil and convexity for the spindle anvil. Although I had checked with a dial test indicator that the axis of the mill/drill was square to the surface plate, evidently it was not square enough or was not held true in the chuck. Needless to say, if you lap things this way and do get a flat surface, it must necessarily be square as well.

I decided to eliminate the milling machine spindle. I faced a 50 mm length of cast iron bar of about 50 mm diameter and then cut a few shallow grooves in the face with a hacksaw (Photo 21). I then returned the bar to the lathe and faced it smooth again before boring and lapping a hole through it to a very close sliding fit on the plunger. I loctited the anvil into the plunger, oiled the plunger and put in into the bore of the jig just made. It was then a matter of rubbing back and forth in large, patient zigzags on the lap, maintaining firm contact and lifting and rotating the plunger every ten strokes. From time to time the lap was also rotated randomly to evenly distribute the wear. After working through Brasso and cerium oxide I still had a

convex surface, but only one fringe, or a departure from flatness of 0.25 microns. Attempts to get it better left me where I had begun, with four fringes. I evidently need some tuition from my telescope making friend before I can get the perfectly straight and regularly spaced lines shown by the tungsten carbide anvils of my Mitutoyo micrometers.

W. M. Thomas wrote, some seventeen years ago "After some twenty-five years in precision grinding in the manufacture of all types of gauges. I am more than ever



Jig for second attempt at lapping anvil flat.

convinced that nothing made by man is ever truly round or truly flat." I can only echo heartfelt agreement after my own effort at instrument making, shown finished in Photo 22.

Postscript

I am sure that some readers will be apprehensive regarding the method of spot grinding suggested in the article. It is apparently an acceptable method, used in precision instrument and gauge manufacture. The method is fully described in the book, *Practical Engineering Metrology* by K.W.D. Sharp, published by Pitman of London in 1970. Any reader wishing to know more please forward a s.a.e. marked "Spot Grinding".

One vital safety element in the use of this method is that the amount of metal being removed at one setting should not exceed 0.005mm, while for the purpose of finishing the cut should not be more than 0.002mm - Ed.



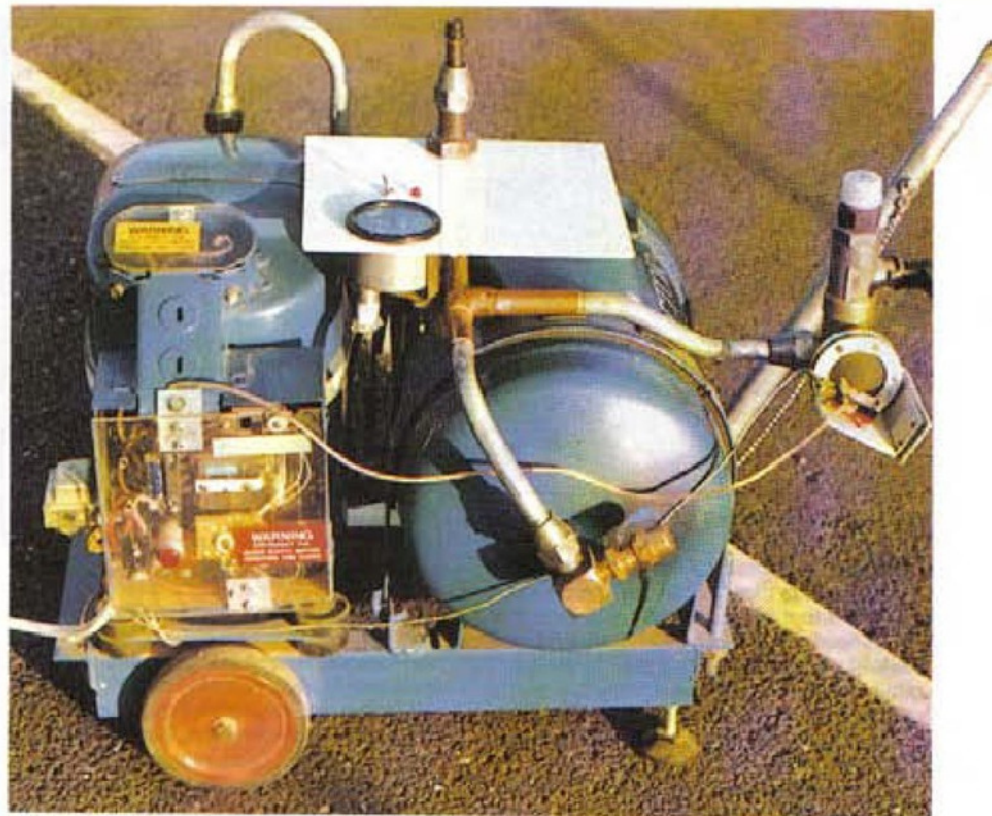
Finished differential screw micrometer head.

Martin Howell describes his method of making a small workshop compressor at minimal cost, using largely recycled materials. Construction by this method could open up the possibility of owning a readily available source of compressed air in the workshop – it could otherwise be impractical on the grounds of cost.

Introduction

This article describes how to build a small air compressor at minimal cost, using components that are readily available. No special tools are required, although a welder is useful.

An important point is to decide what you plan to use your compressor for, since this will determine some of the design. For example, I use mine mainly for paint spraying with an air brush, which only needs about 35 psi, and which connects to



Above: A general view of the finished compressor. The Perspex covered box houses the relay and other electrics. This is an old style compressor, more modern units are smaller and have simpler electrics. Below: Another view, the black container is the air filter.

BUILDING A SMALL COMPRESSOR

the compressor using a standard car tyre valve. If you plan to use more pressure, you will need to make modifications to the plumbing and use different types of connections for your appliances.

This is perhaps a good time to include a serious safety warning. Compressed air, even at fairly low pressures, is dangerous and needs to be treated with respect. A jet of high pressure air can blast sharp objects

into your eyes, or even force air bubbles into your blood stream with potentially fatal results. You need to make sure that your compressor is constructed carefully and safely to avoid accidents caused by component failure, and you need to be very careful how you use the air.

Properly built, your compressor will cost you very little to construct, and will give years of faithful service: my original design

has been in regular use for around six years, and cost me less than £15 to build. If you compare this with the cost of a commercial unit, the DIY approach has much to recommend it.

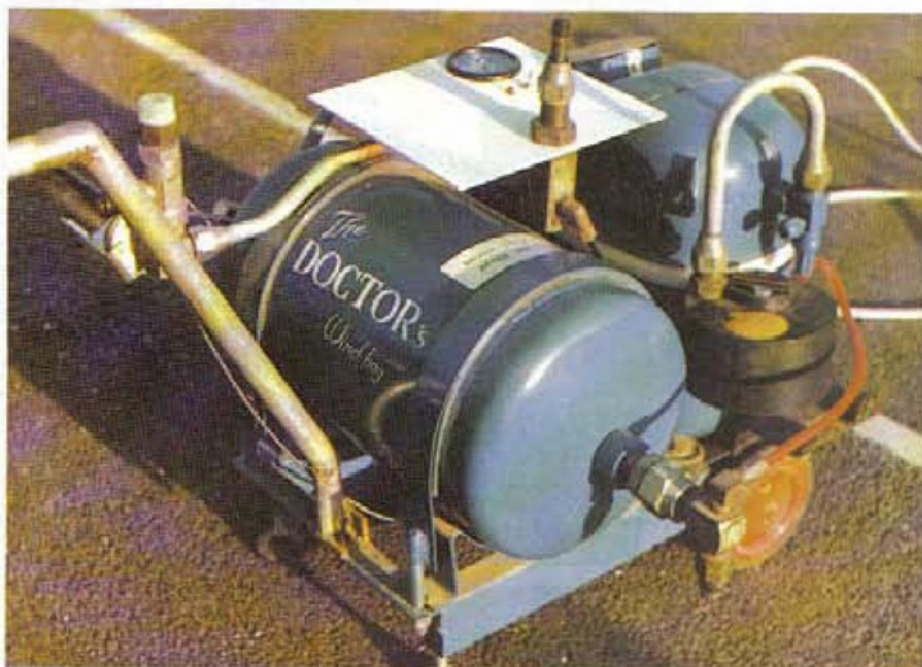
Basic components, and where to find them

The parts that you will need, and the likeliest places to find them, are as follows:

- 1) The compressor unit from a domestic refrigerator – from a junk yard.
 - 2) An air reservoir from a truck – from a car or lorry breakers yard.
 - 3) Various pipes and pipe connectors – the breakers yard again.
 - 4) Some electrical switches and other components – from an electronics store.
 - 5) Steel angle or tubing for the frame – steel merchant or scrap dealer.
- You will also need things like nuts and bolts, some wheels, and some rubber door stops.

The tools that you will need are simple as well:

- A power drill, preferably in a bench drill press
- A selection of spanners and screwdrivers
- A small blowlamp and a soldering iron
- A welder is useful for the frame, and some taps for threading holes make life easier.



The compressor unit

The compressor itself is a readily available unit: a pump from a domestic refrigerator. The vast majority of fridges are scrapped because they are old, tatty, or the door seals no longer work. Some spring a leak in the pressure system, and others just start to fall to bits internally, or their steel casings go rusty. Whatever the reason the fridge ended up in the junk yard, it is highly unlikely that it is the compressor unit that failed.

If you are really unlucky, and the unit that you choose to strip is the only one in the yard that has a defective compressor, so what? There are probably dozens of others in the same yard, so just keep going back until you get one that works.



The underside of the reservoir showing the drain valve and mounting straps. The reservoir should always be drained after use by releasing the stored air through this valve.



The outlet end of the reservoir, showing the brass safety valve.



The inlet end of the reservoir showing the plastic feed pipe from the compressor, and the one way valve on the reservoir.

A fridge mechanism consists of a pump which circulates a volatile gas around a closed loop, alternately compressing it and then allowing it to expand. The compression and expansion cycle both absorb and gives off heat, which is why the inside of the fridge is cold, but the network of pipes on the back is hot. The pump is a very effective compressor, and this is the unit that you are after.

If you look at the back of the fridge, there is usually a black painted framework of fine tubes arranged in a ladder formation, and these are connected to a squat black lump, usually in a recess right at the bottom. Depending on the size and the age of the fridge, the lump may be large or small – older compressors were much bigger than more modern ones, and bigger fridges need more cooling and hence a more powerful pump.

The compressor consists of a motor and a compressor unit, combined into a single unit, hanging on springs inside a welded steel canister. The canister is actually a vacuum chamber, with a pipe brazed on to allow the refrigerant gas to enter. The output of the compressor is similarly fed through the wall of the canister, and sealed with braze, or sometimes with a rubber seal. Similar seals are used to feed the power cables inside to the motor.

If you are really curious, you may want

to look inside the canister: I did. The canister is made in two halves, top and bottom, that fit together in the centre and are welded together at that point. If you carefully cut through all around the welded seam with a hacksaw, you can separate the two halves enough to see and get at the insides. When you reassemble the whole thing, you can re-weld it, if your welding is up to the job, or use a silicone sealer all round the joint with insulating tape bound around the outside just to make sure. Since the canister is a vacuum chamber, it doesn't matter too much if air leaks in through this seal, except that it is not filtered.

When used in a refrigerator, lubrication is provided by the refrigerant fluid itself, which fills the canister with vapour, although most units have oil as well. To ensure long life for your unit, the subject of lubrication needs to be considered in some depth. We will look at this again later in this article. As far as the scrap dealer is concerned, the compressor is just a lump of assorted metals, and a nuisance as well: he earns his money by sorting metals into different piles – steel, copper, aluminium, etc. – and the compressor contains at least three different metals which are very difficult to separate. In my experience, he will be only too pleased to let you have one for a fiver, and will readily agree to

exchange it for one that works if the first one is no good. From his point of view, a broken unit has the same scrap metal value as a working one, after all.

To avoid any unpleasantness, *always* explain what you want to the yard owner before you start. For obvious reasons, they do not like people just coming in and ripping the entrails out of a fridge and saying "How much for this lot, then?". For one thing, scrap yards are potentially dangerous places, and for another, he may have been keeping that fridge for his old mother or someone.

Also remember that junk yards are dangerous places, full of sharp and rusting metal, mud and oil spills. It is all too easy to slip, or trip, and finish up with a bad gash that can readily become infected. Most yards also have a couple of mangy dogs hanging around as well, and these may take a sudden and unwelcome interest in tearing the seat out of your trousers: an implement like a broom handle is useful for poking about in the junk, and even more so when used to discourage the mutt who is trying to take a piece out of your leg. Most important: don't take children along with you, how ever much you enjoy their company – what is merely dangerous for you can be lethal to a small child, so leave them at home. You may find a yard with a pile of compressors already removed from

their fridges. While this makes it easy to choose one and take it home, it does make life difficult when you need to work out how to connect it up. They are usually removed by the yard owner with the fine precision of a sledge hammer, an axe, or a chain saw, and serious mechanical damage is likely as a result. Last, but not least, there is unlikely to be any lubricant left inside, and the dreaded rust may have taken root on cylinders and shafts – they may be worth a gamble, but you are better off extracting one from a complete fridge.

You will need to get the unit out of the fridge. This entails three moves:

- 1) Disconnect the electrics
- 2) Disconnect the plumbing
- 3) Remove the mounting screws

1) The electrics

These vary with the age of the fridge, older units being more complex. You need to carefully trace the wiring from where the mains cable enters the machinery, noting all the places on the way where there is any kind of a connection.

My suggestion is that you extract not only the compressor, but also as much of the wiring and associated bits as you can, making sure that you have enough wire left hanging from each component to be able to reconstruct the electrics when you get the whole lot home.

Many of the older and/or larger units have a relay to handle the heavy start-up current, and most have a bimetallic sensor to detect when the compressor is getting too hot. None of these items need cause you a problem, provided that

- a) you take them all with the compressor, and
- b) they are all working.

A good idea is to make a sketch of how the unit is wired up, and you may want to take some coloured insulating tape along to mark the wires in case they are not colour coded.

2) The plumbing

This presents a couple of problems. The first has to do with the environment. Most people are aware that serious damage to the ozone layer has already occurred, and will continue to occur, as a result of the use of so-called CFC chemicals. Unfortunately, the fluid used in fridges and air conditioners is CFC based, and it is a sensible idea to try to prevent this escaping into the atmosphere.

This is easily said, but difficult in practice. You should speak to the yard owner, and ask him whether he has a system for capturing the CFC chemicals from scrap fridges. If he does, you need to arrange to get the parts that you need from one that he has already emptied, or get him to empty one for you. If he doesn't, you have a choice to make.

You can either go and find a yard that does siphon off the CFC, (and these are pretty rare), or tell yourself that the yard owner is going to squirt the stuff into the air anyway, so you are not making things any worse.

Only you can decide.

The second problem is that there is rarely a simple one pipe in, one pipe out arrangement on the compressor. There is often a jumble of pipes connected to the unit, and you need to be sure which is

which. Fortunately, it is easy to work out which one does what when you have the unit safely home on your workbench, by the simple expedient of starting it up and seeing which pipe the air comes out of, and which one it goes into. Your major concern in the hostile world of the scrap yard is to ensure that you leave a good 3 to 4 in. of pipes protruding from the compressor when you cut them: you can always make them shorter afterwards, or seal off the ones that you don't need.

Make sure that the fridge is upright before surgery on the pipes begins, or you will find yourself covered in all sorts of oil and other gunge as soon as your saw penetrates the first pipe.

Remember that the whole system is under pressure, and that as soon as you cut into a pipe, the gas will come rushing out. It will be very messy, and very cold as it escapes, and it may squirt out in

3) Mounting screws

Most compressors have a horizontal steel plate welded to the canister, with three or four mounting holes. These invariably have a rubber grommet in each one, with a bolt through the centre of each. To remove the compressor from the wreck that you have now made of what was once a fine fridge, all you need to do is loosen and remove the bolts and lift the unit out.

Try to keep the rubber grommets, unless they are badly perished: they are there to stop vibration and noise, and you will need them (or replacements) on your new machine. They usually have a metal tube in the centre, and these can easily fall out into the mud of the yard. You need these to ensure that the bolts do not tighten down too much on to the rubber, so try not to lose them.

You will find the unit surprisingly heavy:



This unit has the air feed pipe to the tank forced inside the outlet pipe from the compressor and secured with adhesive.

unpredictable directions. I recommend that you wear protective goggles and gloves, and wrap a rag round the pipe where the cut is being made to try to slow down the flow a bit. Wait until the hissing stops before continuing to cut.

Use a small junior hacksaw to cut through the pipes: they are usually made of copper, and quite soft. They also bend very easily, and may collapse if bent too sharply, so you should make sure not to allow them to be strained where they enter the canister – they may collapse or crack at this point, and you will not be able to fix it if they do.

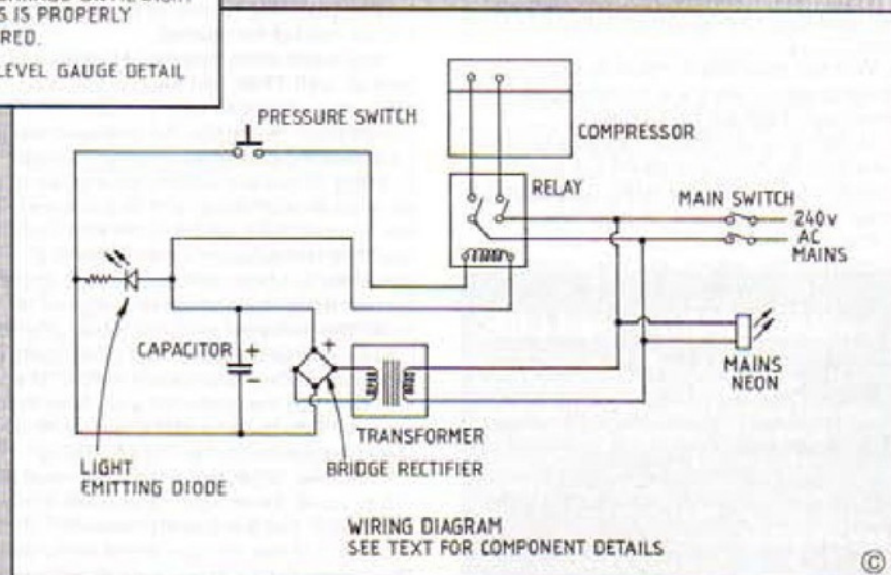
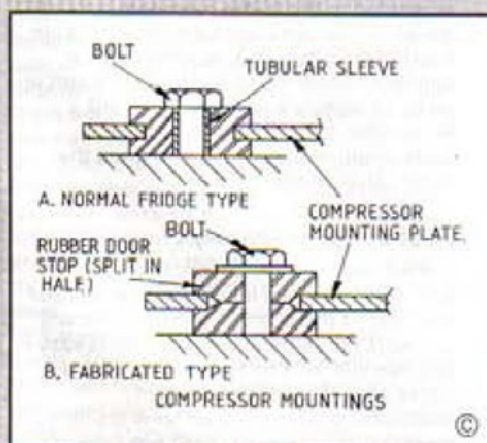
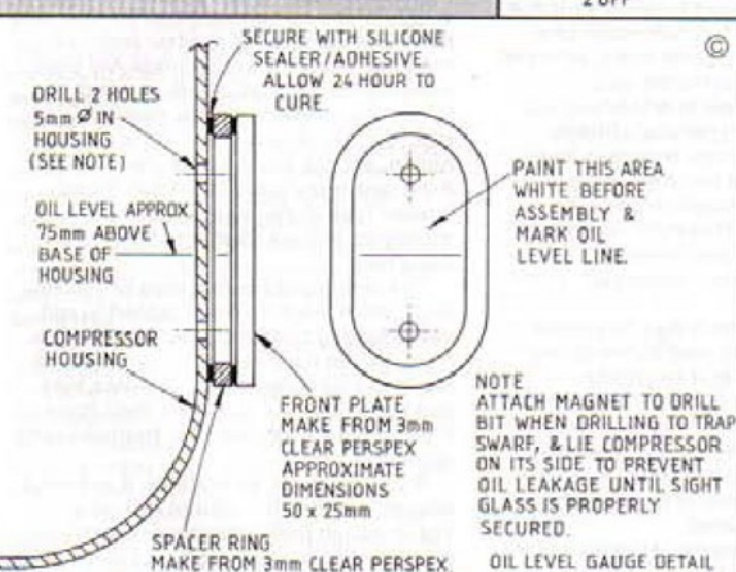
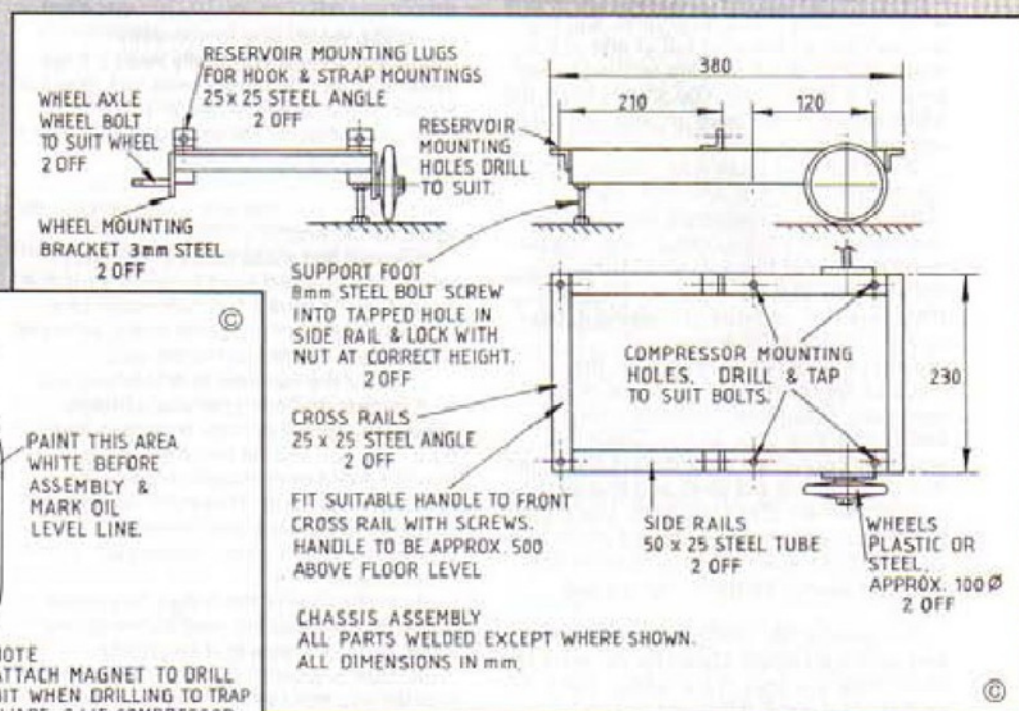
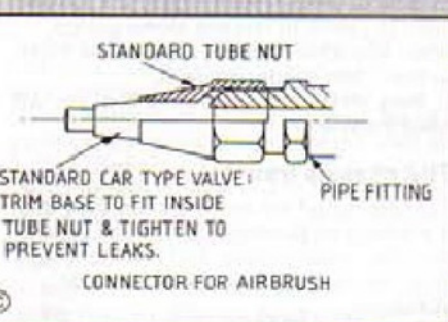
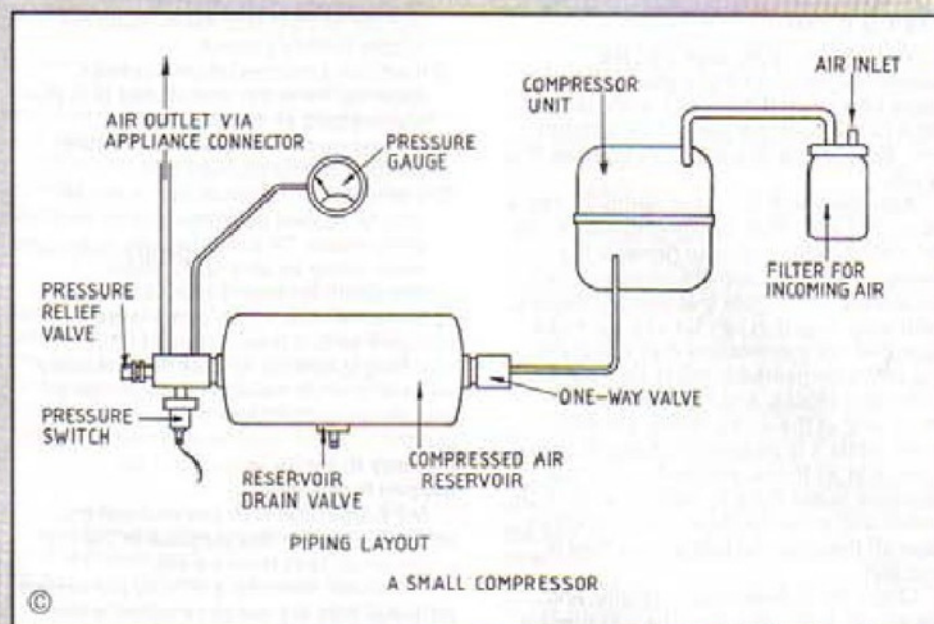
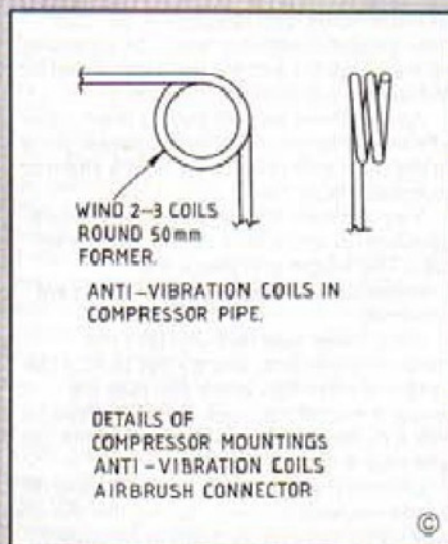
Once you have cut through the pipes, seal up the ends of the ones on the compressor with insulation tape. This will prevent dirt from getting inside, and stop oil from leaking out into the boot of your car on the way home.

Bend the mangled remains of the rest of the plumbing out of your way for the next stage. Be careful not to cut yourself on the sharp ends of the pipes that you have just cut.

It weighs nearly as much as if it were a solid metal block, which is not surprising because there is not much air space inside. It will also be in an awkward position to get at, and probably oily and slippery, so be careful not to lose your balance, or have the beast slip and crush a finger.

A few simple checks

Time for some rudimentary checking out. Give the unit a gentle shake: you should be able to feel the motor unit inside moving about on its springs. If you shake it harder, you will feel it knock against the inside of the casing, which is normal but not to be encouraged. What it should not do is make a sound that indicates that there is something rattling about loose inside. Any sliding or clanking noises indicate serious mechanical derangement, and it is highly unlikely that the unit will be any good. Unless you have formed a deep emotional attachment to that particular unit, throw it back and look for another one. Wrap your prize in a rag, and keep it upright all the way home.



Trying it out

You need to make sure that the compressor works before you waste any more time on it: if it doesn't work, take it back to the yard and swap it for another one. Keep doing this until you find one that is OK.

Assuming that you have faithfully noted down the way in which the unit was wired up, you should be able to recreate the same wiring arrangement on your bench. As always, remember that you are dealing with electricity that can kill you, so make sure that the connections that you make are safely contained in those little plastic connector blocks, and that you do not touch any of the wires, or the compressor itself, while it is plugged in. Keep the unit upright at all times, and make sure that vibration is not likely to make it walk off the bench and on to the floor. Take the sticky tape off the pipes so that air can flow in and out.

Check the connections carefully, and switch on. If all goes well, the compressor should kick slightly and then purr away almost silently. Switch it off again as soon as you are sure that it is running, and that you can feel air blowing out of one of the pipes. At this point, you are entitled to feel pleased with yourself. You should mark the pipes where the air goes 'in' and 'out' with coloured tape or similar.

If it is not your lucky day, various things can happen. The first unit that I tried started up and immediately disintegrated internally with a resounding bang. The only good part about this was that I knew immediately that the unit was dead, and that there was no hope of reviving it. Back to the yard for another one.

Other than mechanical failure, the electricians are the most likely cause of non operation. Disconnect from the mains before checking your wiring. Check that you have connected according to the notes that you made in the yard, and that all the connections are clean and tight. Disconnect the compressor temporarily and check for a short across the windings or to earth (the casing is always earthed), using a test meter.

If all seems OK, reconnect everything and switch on again. Listen for the relay to click (if there is one). If it is totally silent, it's probably no good. If the unit has an overheat detector – usually a bimetallic disc arrangement mounted on the casing – try by-passing it. (Switch off and disconnect first).

Without touching it, listen to the compressor to see if it is humming or growling – both are bad signs.

Unless you can find an obvious fault in the electricians, if the unit won't run it is probably seized up internally, and therefore scrap. Take it back and get another.

If you have a good one, carefully disconnect the wiring, and seal up the pipes again with tape. Use liberal quantities of rags and cleaning fluid – petrol or paraffin – to remove all the dirt and oil from the casing, then put it to one side for the time being.

The reservoir

The reservoir is essentially a tank, which is filled with the compressed air. It serves several purposes:

- 1) It stores a large volume of air to allow the intermittent use of large blasts of air

that the compressor alone could not supply quickly enough.

- 2) It acts as a condensation chamber, allowing the water and oil that is in the compressed air to condense and precipitate to the bottom of the tank, where it can be drained off.
- 3) It smooths out fluctuations in the air supply, caused by piston pulses from the compressor. This is especially important when using an air brush, where consistent air flow is crucial.

Since the reservoir is just a large pressure tank, it does not need to be anything special as long as it can reliably withstand air pressure. Although a good welder could doubtless build one from scratch, I do not recommend this: it is all too easy to create an accident ready to happen in this way.

My suggestion is to use a vessel that was designed for this purpose in the first place: an air tank from a truck.

These are made for precisely the correct purpose; they are pressure tested when they are made, and they usually come complete with mounting brackets and threaded bosses for the pipes – what more could you want? Size is not really important, unless you really need a large volume of air: the bigger ones will give out air for longer, but take longer to fill up to the right pressure. For general use, I would suggest one of the smallest ones, and if you find that you need more air than this can provide, you can add a second tank the same as the first.

You will find these tanks in breakers yards, and you will need to find a yard that specialises in trucks. You will need other related parts from the same place, so make a list before rushing off to the yard.

Look for the cleanest tank that you can find, so that you can spot any damage. Other than minor surface scratches and light rust, you should avoid any reservoir that is dented or damaged in any way, or caked in heavy rust. These can weaken the structure of the tank and cause a dangerous failure under prolonged pressurisation.

As in the case of the fridge, talk to the owner of the breakers yard before doing anything. Make sure that he clearly understands what it is you are after, and let him tell you from which vehicle to remove the parts you need. He will be rightfully annoyed if you take parts off a vehicle that he was planning to sell, or for which he has a brisk market for spares.

You need some other parts related to the tank as well. First, you need a one way valve that allows air into the tank from the compressor, but stops the pressure leaking back into the compressor once it stops running. There are usually several air tanks on even a small truck, and you need to find the 'master' tank, which is the first one from the compressor – the others are generally fed from this one, via a complex system of valves and pipes designed to make the pressure systems, especially the brakes, immune to failure of other parts of the system. One way valves vary in shape and size, but are generally a square block screwed into the end of the tank, with a threaded connector for the plumbing.

The other, vital, thing that you need is a safety valve. Once again, they vary in size and shape, but are usually mounted on the other end of the cylinder to the entry point. They often have a screw-on cap with one

or more holes in to release the air. This little gadget could save your life, by acting as a emergency exit for the pressurised air in case the pressure switch fails to work.

All tanks should also have a drain valve of some kind, mounted at the lowest point in the tank, and sometimes with a chain or wire cable attached.

You will need to take the pipes that are screwed on to the tank of your choice as well. The length and shape are unimportant, but the screwed fittings are essential.

Also, make sure that you take the mounting brackets, and try not to lose the nuts and other bits when you take the whole thing off the truck. Put the whole lot into a cardboard box in the back of the car, and take it home.

Once in the workshop, carefully take off all the screwed on parts. Some, like the one way valve, may be too tight to remove, in which case leave them on. Clean the whole outside of the tank with rags and a solvent, such as petrol, to remove all the gunge: when you have finished, it should be more or less clean enough to paint.

Keep all the other parts in a box: you will need them later.

The chassis frame

There is no hard and fast design for this: it depends on the material that you have, how they are mounted, and whether you need the compressor to be portable or stationary.

Basically, what is important is that the frame is strong enough to support the weight of the compressor and the tank, and that it is shaped so as to allow both to be mounted properly and securely. My basic design is for a portable type, in which the frame is a simple rectangle, welded together. The side rails are 2in. x 1in. tubing, and the cross pieces are 1in. angle. If the tank is mounted in the half round 'cradle' type of mounting, then the fixing screws for this are fitted into holes in the cross rails.

The compressor is mounted on the side rails, which are drilled and tapped to suit the mounting bolts that you intend to use. If you do not have access to a welder, the frame can be bolted together. Make sure that the bolts are a snug fit in their holes to prevent the whole assembly from slopping about.

If your unit is to be portable, it will need wheels, around 75 – 100mm diameter. These should preferably be steel types – plastic ones are easy to get, but may not be not man enough for the weight. They will need to be mounted on brackets, screwed or welded to the frame members. I generally use only two wheels, with skids fixed to the other end, together with a handle to allow me to tip the whole unit up on to its wheels and move it around. Remember to leave enough room underneath to allow you to operate the drain valve on the reservoir.

First stage assembly

First, you need to ensure that there is sufficient (any?) oil inside the compressor chamber: if there isn't, your machine will not work for very long. Adding oil is easy – you can just let it be sucked in by the air intake pipe. The difficulty lies in establishing the correct oil level inside a steel casing which you can't see through.

The oil level must be high enough to make contact with the compressor mechanism inside, which it then lubricates by a combination of splashing, frothing and immersion. If the level is too high, however, the oil will work its way into the cylinders and be forced into the air supply. On balance, it is better to have too much than too little - the oil in the air will be mostly captured in the reservoir - although if the compressor's piston is not a good fit, the cylinder can fill with oil when stationary and this will cause widespread destruction inside the machine when the unit starts up again. As a rough guide, I fill the chamber up about one third to one half of the way up to the central joint, and position the sight glass accordingly. Make sure that the sight glass is carefully sealed, and that the sealer is cured, before turning the unit back the right way up. The chamber is under vacuum, and this will tend to improve the seal when the unit is running, although it will also break the perspex plate if you make it too big...

You can make a sight glass by drilling two holes in the casing, one above the other, and enclosing them with a see-through arrangement that prevents the oil escaping and allows you to see the level of it. (See diagram for details). You should lie the compressor down to drill the holes, and stick a magnet on to the drill bit to capture as much of the swarf as possible during drilling.

You should not connect any of the pipes or the electrics until the basic units are mounted on the frame and painted. Before any assembly takes place, clean off all the components ready for painting. Put tape over the ends of all pipes and screw threads to keep paint off them. Paint everything with a good metal primer. You can use either a brush or a spray can, but make sure that every part gets a good coat: you are more interested in protection than appearance, so don't worry too much about brush marks or dribbles. My preference is for a brush rather than a spray - it lays down a thicker coat of paint, and costs considerably less, as well as being less messy.

Start the assembly process in a place where the unit can be worked on easily, and where it can stay until it is finished. If you assemble it on a bench, remember that it will probably be too heavy to move single handed once assembled, so you will need a hoist, or a strong assistant.

Once the paint is dry, assemble all the components. Mount the reservoir on to its brackets, and fit to the frame first, making sure that all the screws are done up tight. Fit the compressor unit to the frame, making sure to use the rubber mountings salvaged from the fridge. If these are no use, or lost, take rubber door stops, drill a hole down the centre of each one, and split them horizontally with a hacksaw. Mount one half below the mounting bracket, and the other one above, and use a bolt with a large washer to pinch the whole assembly together. Make sure not to do the bolts up too tight, or the sound absorbing properties of the rubber will be lost. Also, try to make sure that none of the bolts touch the mounting bracket, or noise will be transmitted through it and into the frame. This may seem unnecessary, but the noise can become irritating in a confined and quiet place, such as an artist's studio.

Do not fit the wheels, or anything else

that must not be painted at this stage.

Check for scratches in the paint, and touch up as necessary. While you are at it, paint the nuts and screws used to mount the reservoir, and any other screws that are not plated.

Now that you have the major units in position, it is time to look at how to connect them all up.

The plumbing

Like the frame, the layout of the pipes to carry the air around will depend on the various parts that you have obtained from the breakers yard. Do not worry if your pipes are all the wrong shape; all that matters is the screwed connectors that join the pipes to the other bits of machinery.

You will need some other parts, apart from the pipes themselves:

- 1) A pressure gauge, together with the plastic feed pipe and screw connectors
- 2) A pressure switch
- 3) Some pipe connectors with threaded connections suitable for connecting the pressure gauges and switches.
- 4) Some means of connecting whatever tools you plan to use with the compressed air: a standard car tyre valve is a good connector for an air brush, but you may need to buy the real connector components if you plan to use other tools, like spray guns, sand blasters, or whatever.

The diagram shows the pipes that you need to connect.

There are two main pipes needed: from the compressor to the tank, and from the tank to the outlet connector(s).

The pipe from the compressor to the tank must be proof against vibration, or it will work harden over a period of time and start to crack due to the vibration of the compressor. You can use either a plastic tube, or a piece of metal tubing with a coil in it to absorb the vibration.

If you use plastic, make sure that it is man enough for the job. It must be able to stand a pressure of at least 150lbs per square inch, and it must not soften at temperatures up to 100 degrees C.: remember that compression of the air makes it surprisingly hot. Most trucks use at least some plastic pressure tubing, and this is ideal, but be careful that it really is brake tubing and not a fuel line: the latter will not stand the pressure.

Trim the end of the outlet tube on the compressor to the right length, and fit the plastic tube using a good hose clip. I always use super glue as well, just to be sure, between the plastic tube and the metal pipe, and in fact have one compressor where this is the only fixing.

Special metal tubing is made especially for brake and fuel lines in the automotive industry. It is formed by rolling a strip of metal into a spiral, so that it forms a double-walled tube, which is then heated. The heat melts a lead or copper coating on the metal, and fuses the coil into a rigid, pressure tight tube. This tube is immensely strong, and easy to bend without collapsing, and the coating makes it corrosion proof, both inside and out. When connecting to a brake, or a fuel system, the ends are flared using a special tool, and a hollow nut is used to screw the tube down on to a mating taper on the fitting. Sometimes, but rarely, joints are made using brass olives.

My preference is to first bend the tube to

the finished shape, and then solder it on to the pipe from the compressor. The tube will solder readily, although you will have to make it as clean as possible, as with all soldering jobs, and file off the zinc coating. You will obviously need to clean the paint and oil off the compressor pipe, and you will need tubing that is large enough to just fit over this pipe. Use a small blowlamp to tin the copper pipe from the compressor, and sweat the metal tube over it.

Alternatively, you could use a brass olive connector to join the pipes.

The tube should not have any right angle bends adjacent to the ends, as these are potential stress points, and it must have a vibration absorber somewhere around the middle: this consists of bending the tube into a spiral, about three coils or so round a former of about 2 in. diameter. The other end of this pipe must be fitted on to the one way valve leading into the reservoir. If the pipe that you have used - either plastic or metal - won't fit directly on to the threaded fitting, you will need to adapt it by soldering, or clamping it in some way to a component that does fit. This is the reason for salvaging all the bits that were connected to the tank in its previous life. Air pipes on trucks are generally large by comparison with the small tubes used on fridges, and you may have to be quite inventive to reduce the diameter of a pipe from around 16mm to 5mm - a lathe can be invaluable here, making small tubular brass adaptors; these are then sweated into place.

Often, the joints and fittings on a truck will have several connections, and you will only need to use one. The rest will need to be blanked off to avoid leaks. The easiest method is to leave a short length of tubing attached to a tubular nut (from the box of assorted pipes that you had in the boot of your car when you came back from the breakers yard). Hammer the end of this tube flat, fold it over and hammer it flat again, if it still leaks, run solder into the folds with a blowlamp.

The outlet end of the reservoir should be treated in a similar way to the inlet, although here there are some different considerations. For one thing, there is no need to be concerned about vibration, since all of that has been damped by the inlet pipe and the rubber feet on the compressor.

Secondly, depending on what you plan to use the compressed air for, you may need to move fairly large volumes of air in a hurry, and that means that you need larger pipes.

I use the full sized truck pipes for this end of the business. Use the threaded fittings from the truck, together with as much pipe as you can, and make up the remaining length with 15 mm water pipe

MILLING FORMULAE

If you need to mill a square or hexagonal head on a piece of round material, the following formula will give the minimum diameter of material required:

Square: $AF \times 1.415$
Hex: $AF \times 1.083$

Alan Jeeves

and associated angles and tee pieces. The standard truck brake piping is about 12 mm diameter, so the water pipe is a fairly sloppy fit over it: as described before, clean everything carefully and solder it all together. Make sure that you fit the tubes together with at least a 20mm overlap to ensure a good airtight joint.

I started this project by warning of the dangers of compressed air, and this kind of joint may sound like a contradiction. It isn't, for several reasons: first, soldered joints are inherently flexible and able to absorb shock and vibration, and second, if the joint does give way, the air will simply break through where the joint is weakest. This will not cause any catastrophic failure, merely a steady loss of pressure which can be easily traced and corrected.

What you should **NEVER** do is to use PVC piping for pressure pipes: it can, and does, give way without warning, hurling lethal splinters in all directions. Always use metal tubing, or plastic tube specifically designed for use with compressed air, which can, at the worst, only split and release the air.

The business end of the compressor is, of course, the point at which you connect your appliance, whatever it may be. One of the drawings shows a method of constructing a termination using a car tyre valve for connecting an air brush: you will have to use your own ingenuity to come up with a fitting that suits your own requirements.

You may well want more than one outlet, to have an air line for blasting things clean, for example, in which case you will need to make up a double or a triple connection, using either fittings from the truck, or from the supplier of the water pipes.

If you want to be really smart, you may find that there is a place near you that specialises in making up new brake pipes for cars and trucks, and you can have your pipes made up to your specifications: it will cost more, but will look neater and be more air tight.

Almost finished with the plumbing now: the only remaining parts to fit are the safety valve, the pressure gauge and the pressure switch.

The safety valve is normally fitted to the outlet end of the reservoir. It consists of a spring loaded ball that seals an opening: when the pressure of the air exceeds the strength of the spring, the ball lifts off its seating and allows the air to escape. Inspect this valve carefully to ensure that the ball is not rusted in place, and that the spring is not broken, rusted solid, or clogged with dirt. Make sure that the holes for the escaping air are clear as well. It's well worth taking the valve apart to ensure that it is perfectly clean, then reassemble it with the spring and the ball both well greased. When you reassemble it, make sure that the cap is well screwed on, and locked in place with the Locknut – if the cap is only held on a couple of threads, it can easily become a lethal projectile once the pressure builds up.

The pressure gauge needs to be fitted to the outlet side of the reservoir as well. It is usually connected to one of the fittings by means of a short length of thin plastic tube, sealed at the ends with screwed fittings and brass olives. Salvage all of these parts from the truck if you can, or visit your local store that supplies spares for such things.

It's a good idea to fit a flat metal plate somewhere on the assembly, and mount the pressure gauge on this. Make sure that it is located where you can easily see it, and drill extra holes for an on/off switch and a warning light. The gauge needs a hole about 2 in. diameter, and the easiest way to cut this is by drilling a series of holes in a circle, punch out the remaining metal with a small cold chisel, and file to the final size.

The pressure switch is a vital part of the operation of the compressor: without it, the only control over the air pressure is to either switch the power off when the gauge reaches a certain point, or leave the compressor running all the time and rely on the periodic shriek from the safety valve to keep some element of pressure control. Much better to use a switch that can be made to do it automatically, and quietly.

At this stage, all you need to worry about is where to mount the pressure switch. Once again, it must be on the outlet side of the tank, so that, like the gauge, it reflects the pressure in the reservoir and not in the tube from the compressor.

The switch, hopefully, came from the truck that you have already butchered. However, it may not switch at the pressure that you need, or it may easily be faulty. The pressure at which it switches is stamped on the casing, usually expressed in Kpa.

The only way to know if it works is to try it. If you are not sure, off to the shop that sells spares for truck brakes for a new one: you may need to do this anyway, if you need it to switch at a different pressure. You can make your own fairly easily, to give more flexible control over the pressure.

Plumbing all done now? A coat of paint, and on with the electrics.

Electrics and final finishing

This is probably the simplest part of the whole assembly. You will only need a couple of parts that didn't come from the junk yard: a relay, a transformer, a switch, and a light.

The relay is a mechanical switch that is operated by electricity. This makes contact faster and more consistently than you can do it by hand, and since you will want the compressor to maintain pressure automatically, there will be a lot of switching on and off going on as the pressure rises and then falls.

Relays operate using the principle that an electric coil with current flowing will create a magnetic field that can be used to attract a piece of steel: when the power is switched off, the magnetic attraction disappears, and a spring pulls the piece of steel away again. The steel is attached to thin blades with contacts on the ends, and the movement in and out either makes or breaks the contact, and switches the power on and off.

Relays are rated by the voltage that the coil needs to operate without going in to self-destruct mode, and the amount of current that the contacts can switch without suffering the same fate. For this application, you will need a coil voltage of 12 volts, and a current rating of 5 amps or more. The actual power consumption of the compressor may well be stamped or painted on the casing somewhere, and the relay should be rated at this figure or preferably higher.

These days, electronics DIY shops are increasingly rare, but you should find something suitable in a Tandy store, or from Maplin – either the shops or the catalogue.

The transformer is needed to prevent the whole framework of the compressor from being live, a highly undesirable feature. The pressure switch is designed to provide a switching action between the body of the switch and a contact, and if it is used to switch the mains current, the body of the switch, and everything that it is connected to, will carry mains power. Do not try to save the cost of the transformer by missing it out: it could be the last penny that you ever pinch.

You will also need to add a couple of parts to turn the alternating 12 volts produced by the transformer into direct current. This needs a bridge rectifier, and preferably a capacitor to smooth the whole lot out: specifications for all of these bits are as follows:

Transformer: 240 volt primary, 15 or 16 volt secondary, rated at 250 mA or more.

Bridge rectifier: Type Maplin W0005 or equivalent, rated at 35 volts, 1.5 amps.

Capacitor: 1000 microfarads, 35 volt electrolytic.

Note that the capacitor must be connected the right way round: it will be clearly marked with a + or – symbol.

You will also need a switch, capable of standing the switching current for the relay coil, as well as the sustained load of the compressor when it is operating. Look for one with a 240 volt, 5 amp rating or better.

An indicator lamp of some kind is useful to remind you that your new toy is sitting there, full of compressed air and still connected to the mains. The simplest kind is called a mains neon, which should be wired across the mains input lead so that it is always on when the machine is connected, regardless of whether it is actually running or not.

You can use a solid state device, called a LED (for light-emitting diode), instead, but this cannot just be connected across the mains like a neon. The LED must be connected to the 12 volt output from the transformer, using a resistor with a value of 220 to 470 Ohms, and will therefore not show when the unit is connected but not switched on.

You have to take careful note of the polarity of the LED: it's anode must be connected to the + side, and the cathode to the – side. The cathode is identified by means of a small flat on the side if the plastic part of the LED, and the anode usually has a longer lead than the cathode.

Last, you will need some connecting wire – use the kind sold for car electrics – and one of those plastic screw block connectors. If you can find a car-type blade terminal to fit the end of the pressure switch, so much the better.

You can wire all these together as shown in the diagram – pay particular attention to the polarity of the rectifier and the capacitor – using any means at your disposal: the simplest way is to attach all the parts to the solder tags on the transformer, but if you have solder tag strips in your junk box, they will do just fine. Any exposed wires should be covered with plastic sleeving to prevent an accidental short and resultant fireworks. Use a small soldering iron with a fine point, and be careful not to overheat the parts, or



A general view of the compressor, the 12 volt transformer is mounted outside the main electric box to assist in preventing it from overheating.

you will destroy them.

Work out where all the parts will go, and the lengths of wire needed to fit between them: use the diagram to make sure that you connect everything correctly – you are dealing with 240 volts, remember, and a mistake can be pretty catastrophic. Cut the wires to length, and solder them to the appropriate tags on the various parts.

Fit the switch to the hole that you drilled when you fitted the pressure gauge. You will probably find it best to mount the transformer and the relay to the same plate, also the indicator lamp. Make absolutely sure that none of the connections touch any part of the plate or the casing of the compressor, and cover each mains connection with plastic sleeving just to make sure. Remember that the whole contraption will vibrate while it is running, and this may cause things to shake loose and move about in unexpected ways: anticipate the problem, and thereby avoid it. The mains input lead must be connected to the screw connector block, remembering to grip the cable in some way that will prevent a casual tug, or someone tripping over the cable, from tearing the wires out of the connector block. Not only is it an inconvenience to have to repair the damage, the live wires flapping around can be lethal. Clamp the cable in such a way as to take all the strain of a good hard pull, without using anything that might bite through the cable.

The last two jobs are to check all the

wiring, and then check it all over again. If all is well, you should be able to plug into the mains, switch on, and hear your creation purr into life.

If it doesn't, check the following:

The mains. Is the socket ok? Is the fuse in the plug a good one? Are the wires connected properly in the connector block? If the mains neon comes on, then there is power arriving, so look further on.

If you have used a LED in the 12 volt circuit, check if it is lit. If it is not, make sure that you have connected it the right way round: be prepared to go and buy another if you have, because they don't like their electricity backwards. If it lights up, the 12 volt supply is ok.

Check that the relay contacts move when the switch is turned on: you should be able to see them if the relay has a transparent case, and hear them if you listen carefully. If the relay is ok, the fault is either in the wiring from that point on, or the compressor is dead.

If the relay does not operate, take the pressure switch out of the circuit by bridging it with a length of wire. If the relay pulls in, then the pressure switch is faulty and needs to be replaced – you can't take them apart to mend them.

Make sure that there is a complete circuit between the pressure switch and the relay coil. It is easy to overlook the fact that the switch may actually be insulated from the rest of the machinery by plastic pipes.

Generally, the most likely cause of the

system not working is likely to be the transformer/rectifier combination, and the most likely cause of that is overheating when the parts were soldered together.

With the compressor burbling away happily, carefully listen and feel all of the joints to search out leaks. You can generally hear the air escaping, but you can also dribble water or thin oil round the joint to spot a leak. Screwed joints can be tightened, solder joints must be re-soldered if they leak. If screwed joints don't respond to the spanner treatment, use a thin film of silicone sealer on the mating faces, do the joint up tight and leave for 24 hours before trying again. If it still leaks, it must be damaged in some way, and will probably need to be replaced.

Other parts and things

It's a good idea to filter the air that feeds the compressor, to keep general dust out of the works. This is especially true if you plan to use it for sand blasting, which creates clouds of abrasive dust that will get sucked into the compressor. Time to exercise your imagination. I find that a plastic jar, with a filter made from a piece of sponge, works very well, and will not impede the flow of



A close-up of the pressure switch. This is a home made unit designed to switch at low pressures, not exceeding 30 p.s.i. The tap seen above it is not part of the switch!

air. It is also fairly light, and does not put too much load on the pipes. Alternatively, you can also use an oil bath filter, allowing the incoming air to bubble through a jar half filled with light oil, but this is heavier and potentially messy. Whatever you use, it will need to be cleaned out from time to time, or replaced.

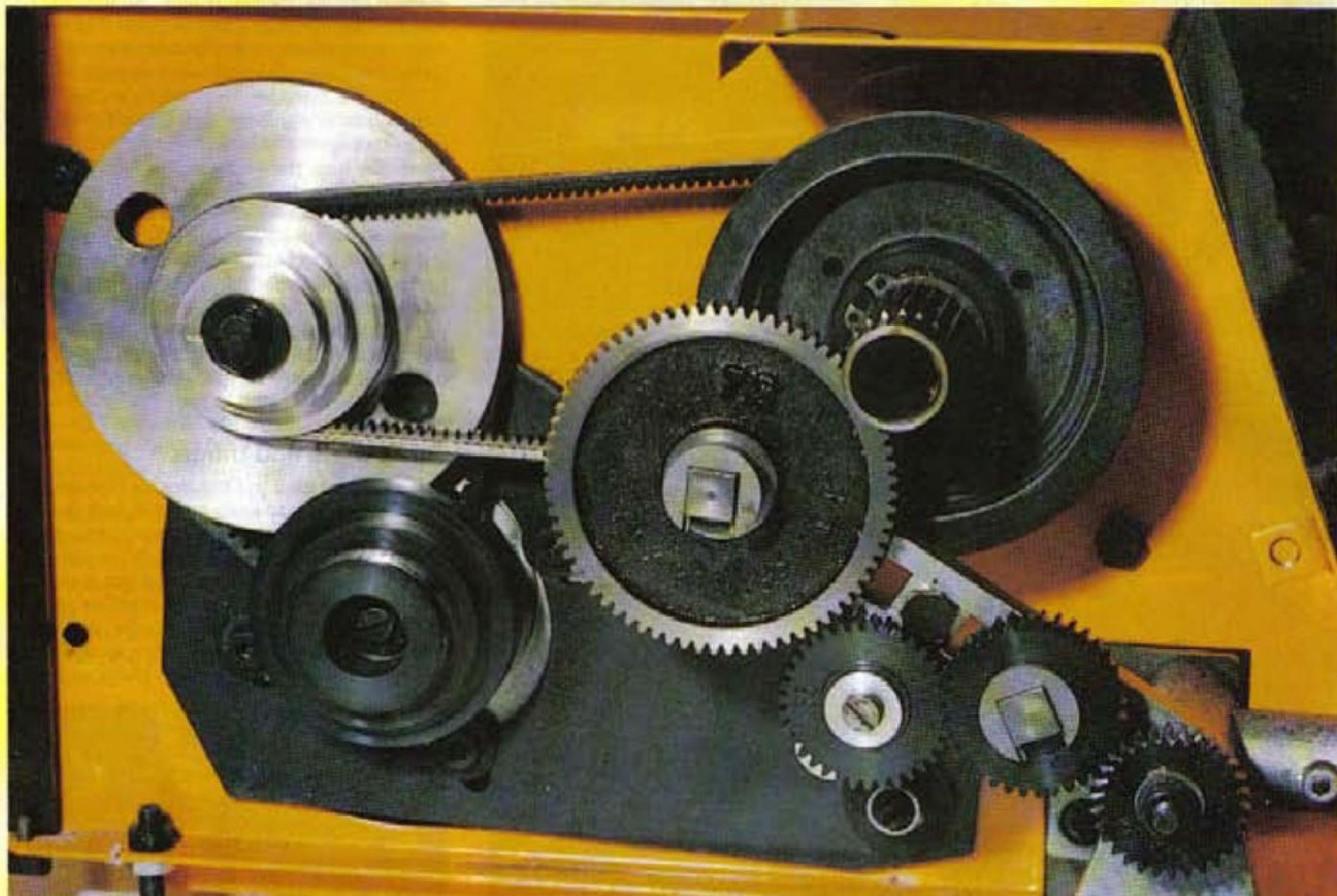
An easy way to paint the whole assembly is to spray it, using the compressor to provide the air. Make sure that you carefully mask off any parts that you do not want to paint – such as the pressure gauge, and the electronics round the relay and transformer.



QUICK TIP

It may be useful to note that the length of head of a socket head cap screw is always equal to the diameter of the thread.

Alan Jeeves



The bracket and quadrant in place.

CUTTING LEFT HAND THREADS

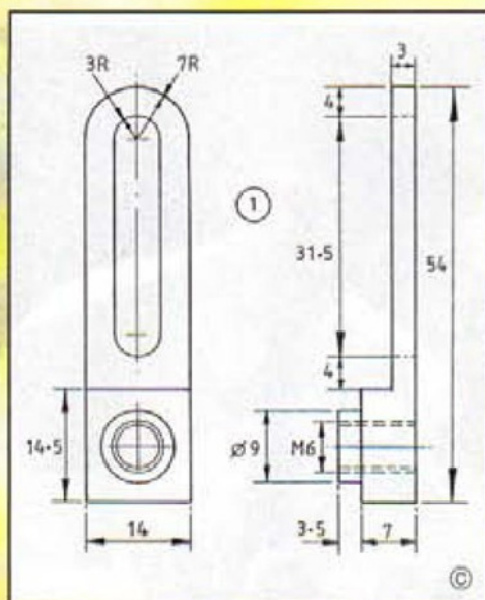


The finished parts.

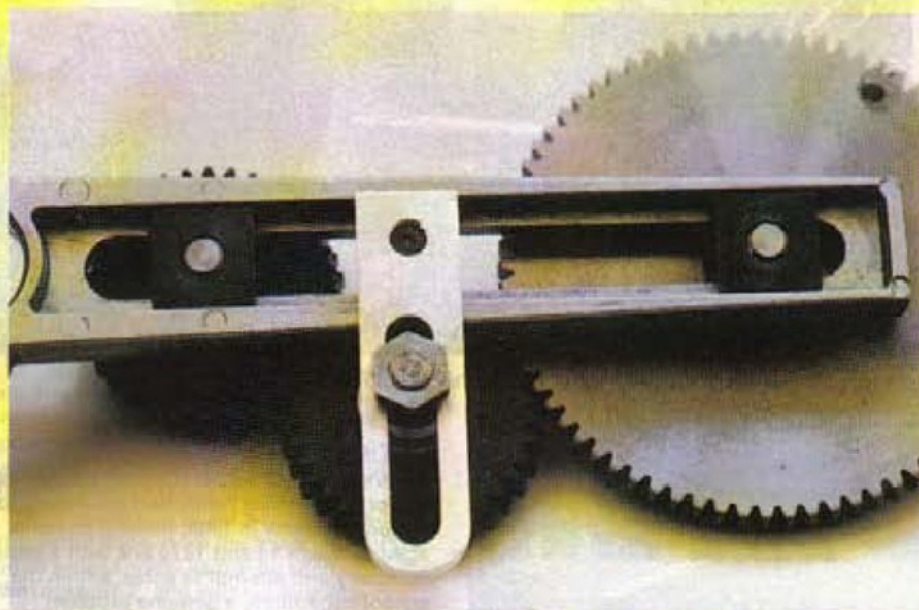
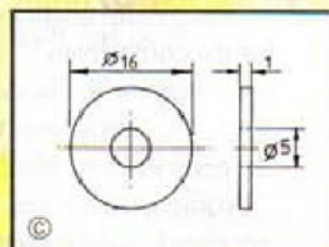
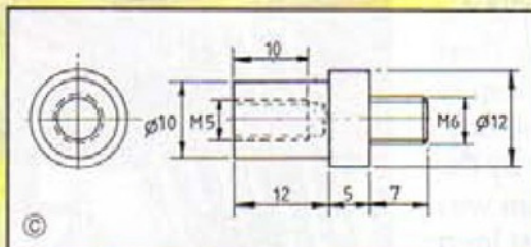
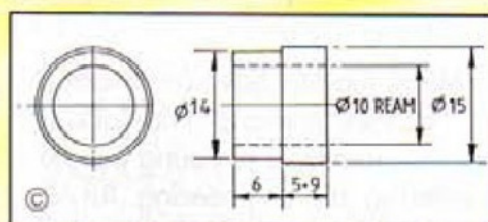
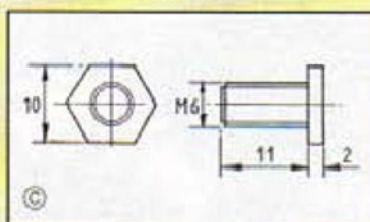
Cutting a left hand thread is not a frequent requirement for most readers; however, if a need occurs then it is probable that particularly on smaller lathes, this may be found an impossible task. Joe Briffa of Malta has overcome the problem on his Emco Compact 5 lathe, the method is likely to be applicable to many other small machines

When I started building the *Matador 60* using the Emco Compact 5 lathe all went well until I came to cut a screw thread on the front housing. The instructions called for a 1.5 in. dia. 24 TPI L.H. thread. I was stuck; the Compact 5, although a very versatile lathe, could not cope with L.H. threads, and I had no access to a lathe that could. I had two options: either find a place where I could have it done for me; or come up with some sort of gadget that could turn my Compact 5 into a L.H. thread cutting lathe. I opted for the latter.

What I needed was some sort of contraption that would move the saddle away from the main spindle as the spindle revolved counter clockwise. By introducing another gear in the gear train, the leadscrew was made to revolve in the same direction as the main spindle. The



All dimensions in mm



The assembled parts.

bracket shown was the result. Now L.H. threads are no problem with the Compact 5.

Construction

The bracket 1 is quite straightforward. I made this from Dural, as it takes very little stress. The bracket is threaded M6; the square part is inserted into the quadrant slot and secured by means of bolt 2. Once it is decided on a particular thread that it is wished to cut, choose a gear that will fit into the gear train. The number of teeth on

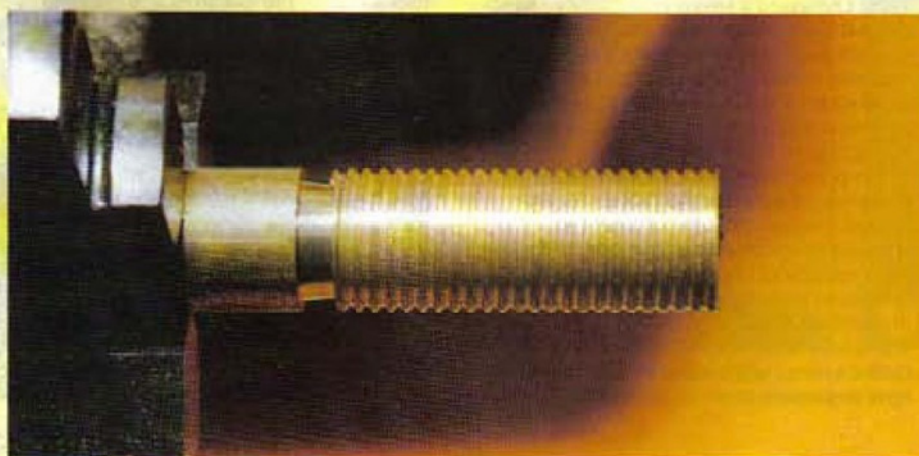
Materials list

- 1) Bracket - Dural. Make to suit lathe, dimensions shown are for an Emco Compact 5.
- 2) Bolt - 10mm hexagon must steel (although any other size with a larger diameter is also suitable).
- 3) Gear spindle - Silver steel.
- 4) Gear spacer - Silver steel.
- 5) Washer - Aluminium.
- 6) 5mm - Cheese head screw.
- 7) 6mm - nut.



Above: Rear view of the bracket fitted to the quadrant.

Left: A 24 TPI L.H. thread which was screwcut using the attachment.



the gear is not important since this is an idler gear. The bracket is then secured by tightening the bolt. For final adjustment, to mesh the idler gear with the gear train adjust the gear spindle 3. This is done after first inserting the spacer 4 and then the gear. The gear is then secured with the M5 bolt and washer 5.

Make the gear spacer a push fit for the gear and a free fit on the gear spindle.



Many readers have commented on their concern at the lack of numbers of young people entering into engineering. An oft asked question is "Where will the model engineers of the future come from?" This short item will, I hope, help to brighten their day. By coincidence, almost by the same post as this item was received, was a request for a design for such an item to be published in *M.E.W.* I considered approaching Gavin, but seeing that he is attempting to make a commercial proposition out of the design, I felt that this would be an unreasonable request. We do congratulate Gavin and hope that the project will be a success in every way



Maggie Philbin congratulates Gavin Rex on his YORTEK Award-winning metal roller/bender for model engineers.

THE YORTEK AWARD

Sound engineering skills and technical ability were the qualities which impressed the judging panel - chaired by TV science and technology correspondent, Maggie Philbin at the 1993 YORTEK Award to Schools final held in Harrogate recently.

Gavin Rex (18) from Joseph Rowntree School in York was the proud winner of the coveted 1993 YORTEK Award trophy for the portable sheet metal roller/bender he designed and constructed for use by model engineers.

A model engineer himself, Gavin makes scale models of traction engines and locomotives. The problems he experienced in bending metal to make wheels and casings for boiler sections inspired him to design his own metal roller.

"Although there are several machines on the market aimed at industrial uses, there is nothing really suitable for model enthusiasts working in small workshops at home," said Gavin. "My design is small, portable and easy to use and allows model makers to bend and roll metal to almost

any specification."

Not only did Gavin present the judges with an excellent piece of engineering design, but also a sound marketing strategy - one of the key factors the judges were looking for in all the projects submitted.

Gavin beat off stiff competition from over 50 project entries from schools across North Yorkshire - the highest entry level yet in the YORTEK Award's seven year history - which ranged from an ultrasonic fall-alarm system for elderly people and a portable Ultra violet radiation monitor, to a universal oil filter removal tool, to a machine designed to rivet and bend electrical switch gear using hydraulics and pneumatics.

On presenting Gavin's trophy and the first prize of a Roland A3 plotter for his school, Maggie Philbin commented: "It is so good to come across someone who has the foresight to consider every aspect of a new idea, including its marketing. During my time at Tomorrow's World I met so many inventors who had come up with brilliant ideas but had no conception of how to present them to the public."

YORTEK - the Association of High Technology and Related Growth Industries in North Yorkshire - launched the Award to Schools scheme in 1986, inviting students aged between 14 and 18 to link with a local company and attempt to solve, within the school curriculum, a genuine problem being experienced by that company. Since then the criteria has been widened to encourage students from a wide range of technology subjects to work with a local company on their own ideas or inventions and to develop them often to finished product stage.

The aims of the Award are firstly to develop working links between the county's students and local industry which demonstrate that the school curriculum has a direct application in a constructive and stimulating way to contemporary challenges encountered in industry.

Secondly, it aims to encourage young people towards a career in modern industry; and thirdly to demonstrate to industrialists the initiative and creative skills which are being developed within schools in North Yorkshire.



SURPLUS SIMILARITIES

When buying surplus or second-hand taps and dies, if NF or NC threads are encountered, these are essentially the same as corresponding UNF or UNC threads with the exception of 1in. NF which has 14 tpi whilst 1in. UNF has 12 tpi.

Alan Jeeves

1 The Pencut Attachment.



Very few workshops have the benefit of a guillotine, even a foot operated one, for cutting sheet metal, and have to adopt less satisfactory methods. This attachment for use with a hand drill, electric or air, is most definitely worth considering as a good, albeit not perfect, alternative

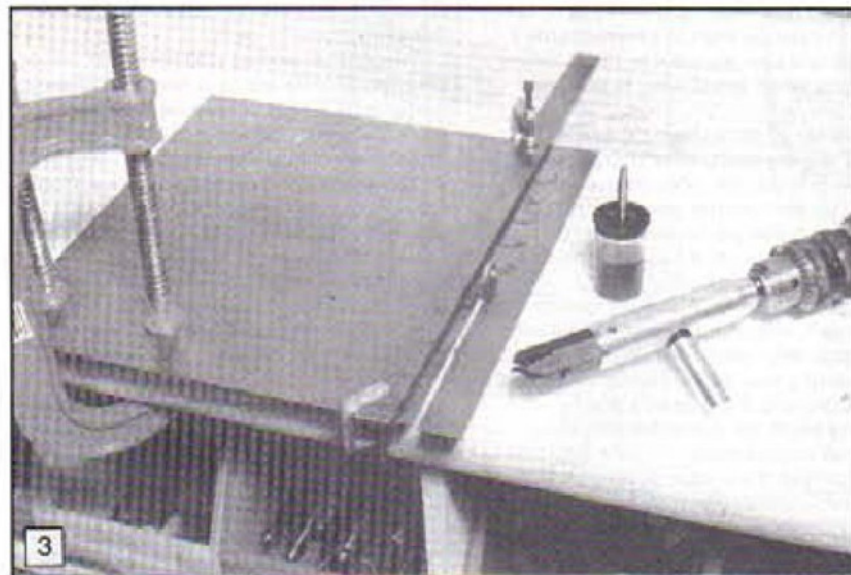
We review - THE PENCUT ATTACHMENT

The Pencut sheet metal cutting attachment, **photograph 1**, for fitting to any electric or air operated drill, has been checked and tested. This is a British made product which gives, from its appearance, the impression of being very well made, an impression which is not changed when it is put to use.

The operation is to cut a continuous strip, 3mm wide, from the material. The cut forms a close spiral as can be seen in **Photograph 2**, and surprisingly little pressure is needed to feed the cutter along the cutting line. We will say a little more about that later. The specification quotes a maximum thickness to be cut of 1mm in mild steel and 1.2mm in aluminium. The main tests for this review were carried out on 1mm sheet steel.



Showing how the cut is formed.



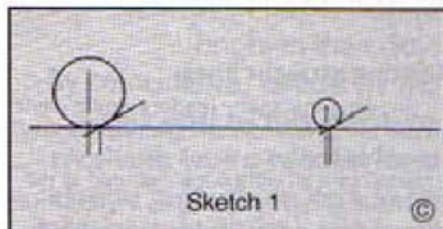
Set-up with a fence to cut a straight line. Oil is recommended to lubricate the cutting blade.



The completed cut.

from two very short test runs, the first real attempt to use the device. Almost certainly with a little more practice a straighter result could have been achieved.

It was not until I had packed up the equipment that I realised why the force required tended to increase past a certain point. The strip of metal being removed forms, as can be seen in the photographs, a close spiral. As this becomes larger it also makes a shallower angle to the metal surface, and as a result makes it more difficult for the cutter to make progress through the sheet, see sketch. However,



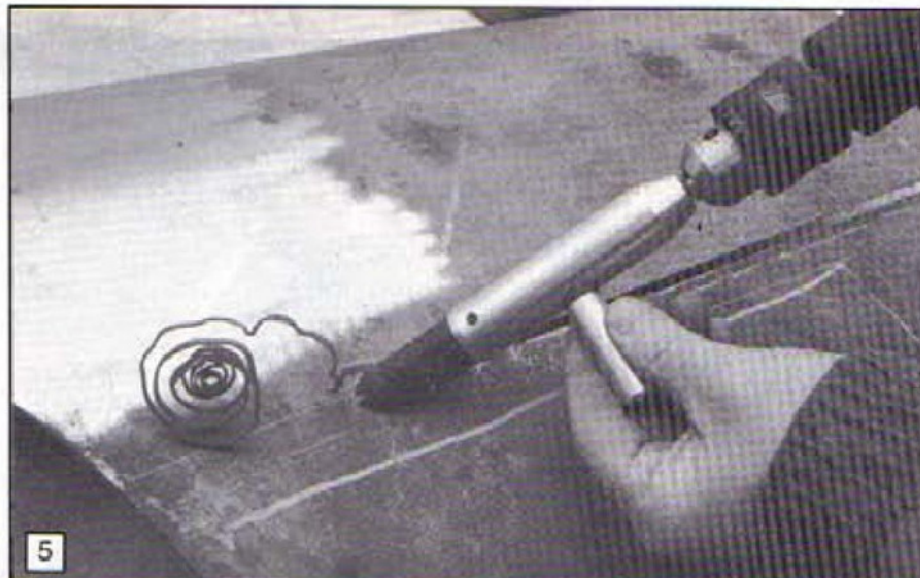
this is not a serious problem as obviously all that is needed is for the spiral to be broken up before it gets too large. With this done it will prevent a spiral reforming; **photograph 5**, from the suppliers advertising literature, shows it being used in this way, but the operating instructions make no mention of this requirement. Operating the device in this way would almost certainly eliminate the problem of keeping to a straight line encountered with the first test.

The cut edge is very good, almost that of a guillotined edge, as can be seen from the visible edge of the piece of metal shown on the right hand side of **photograph 1**. In this respect, it is superior to an electric drill mounted nibbler attachment. When cutting a strip some 25mm wide as illustrated very little distortion of the cut strip resulted. Another advantage over using a nibbling attachment in some cases would be the absence of many small fragments of metal being formed. This could be particularly advantageous with car restoration or repair work, or fitting a sun roof, where fragments from the cut with a nibbler could get in to the box sections or in to the upholstery.

If precise cutting is required without the benefit of a fence, then visibility of any line marked is excellent. The close-up **photograph 6** of the cutting head shows why this is the case.



The cutter head, showing why good visibility to a line on the material being cut will result.



A cut in progress. Stopping the strip forming a spiral is essential when a longer cut is being undertaken, see text.



Shallow curves can also be cut.

Cutting curves

The cutting blade is very slightly tapered towards the rear, making it possible to cut shallow curves, as seen in **photograph 7**. The taper will also permit it to make minor corrections when attempting to cut to a straight line.

The ability to cut a given thickness of material will depend on the sharpness of the blade and die, the internal strength of the mechanism and the power of the drill being used. It had performed with such ease on 1mm steel, that I was tempted to try something a little thicker, and so progressed to 1.4mm. Again the device worked well, indicating that at 1mm it was very adequately rated. I would not recommend going beyond the makers limit, particularly if the cutters are becoming blunt, for more than the very occasional requirement. Whilst it operates satisfactorily at the thicker size, considerable use at this may cause early failure of the internal mechanism.

It would be interesting to see just what that is, but the temptation to dismantle the device was firmly resisted.

The cutter arrangement can be loosened

and rotated through 180 deg., thus enabling the side handle to project the other way, this may be advantageous in tight situations.

The device worked well and I feel would be a worthwhile addition to any workshop, particularly if only limited facilities for cutting sheet metal are available. The attachment is available, at about £30.00, including VAT and carriage charges, from Frost Auto Restoration Techniques Ltd. Spare blades and dies are also available at around £7.00 each.

For further details send to Frost Auto Restoration Techniques Ltd. Crawford Street, Rochdale. OL16 5NU. Tel. 0706 58619. Fax 0706 860338.

CAKE TINS

Don't let the wife throw out her old baking tins used or making mince pies six at a time. They come in very handy for small components when stripping or reassembling a job. They make good sorting trays, too.

Fettler

PART 2

Following Don Unwin's description, in the last issue, of the early days of the planer, he now continues with the development of the slotter and shaper.

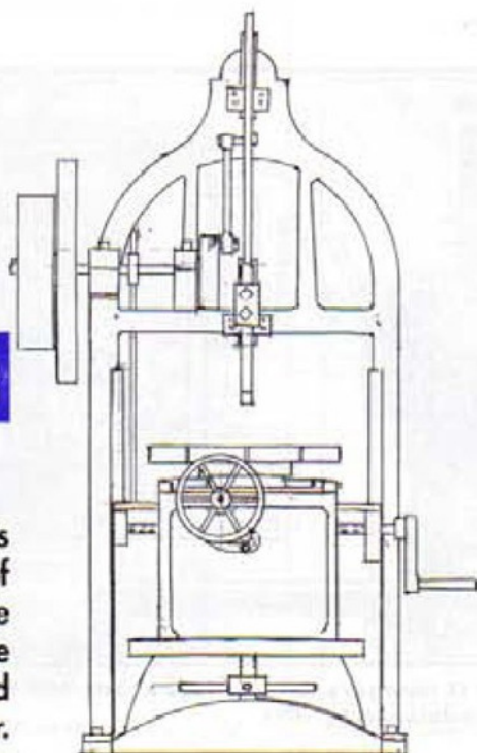
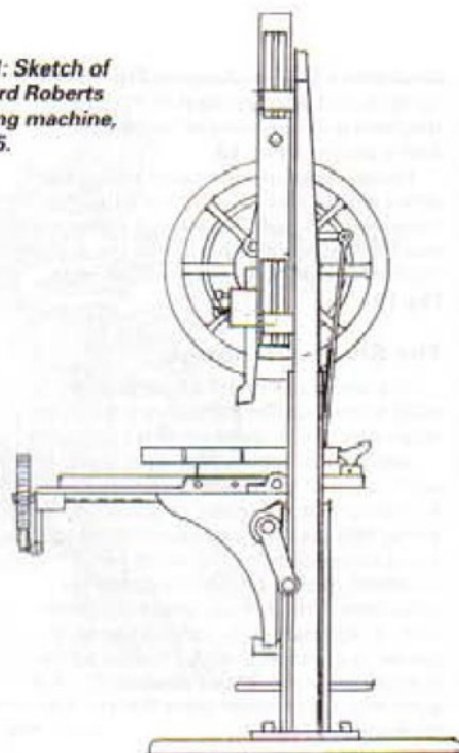


Fig.11: Sketch of Richard Roberts slotting machine, c.1835.



THE SLOTTER

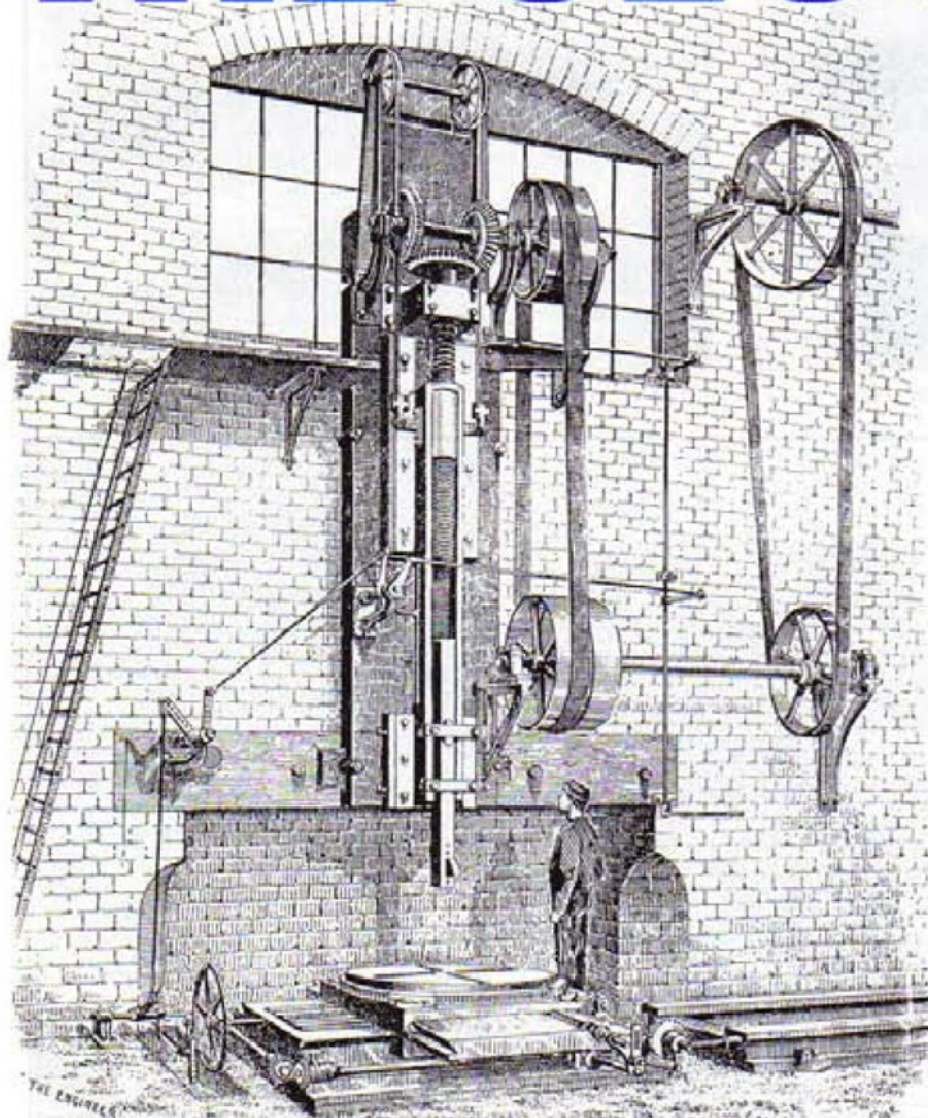


Fig.12: Slotter at Soho Foundry, c.1835. *The Engineer*, 1895.

The slotter

As all wheels, cranks etc. were secured to the shaft by keys, cutting key seats in shafts and key slots in wheel bosses was a problem facing all the machine builders. Charles Holtzapffel in his volumes *Turning and Mechanical Manipulations*, 1847 credited Richard Roberts with the slotter and key seating machines, possibly influenced by his earlier work with Brunel working on the mortising machine for Portsmouth Dockyard blockmaking machinery. (See M.E. 6 August 1993 - Ed.). Wherever the idea came from, around 1835 Richard Roberts had developed a derivative of the planer in which a vertical reciprocating ram, with a tool similar to a parting tool at the lower end, was used to cut a key groove in the bore of a horizontally clamped wheel, Fig.11. Although of rather light construction it did have a tilting table to enable key-slots to be cut in taper bores. Others soon followed, Bodmer in 1839 with a tilting slide and rocking tool holder to give relief on the return stroke and F. Lewis in 1841 with a machine similar to Roberts' but more robust. A very large machine was installed at Soho Foundry about 1835, which like the wall planer was incorporated into the building, Fig.12.

One of the limitations of the conventional form of slotter was the restriction the column supporting the ram placed on the maximum diameter of wheel which could be accommodated. In 1839 one of James Nasmyth's many inventions was a machine to eliminate this problem, Fig.13.

Through time the slotter has not changed very much, mainly in detail improvements, such as stiffness, higher speeds, cutter relief on the return stroke and individual electric drives. A quite large

machine of 1917 is shown in **Fig.14** and a complicated development of 1929 to machine the horn slots of locomotive frame plates in **Fig.15**.

However we use the same principles when we cut a keyway on the lathe, by traversing the saddle back and forth or my manual slotting attachment on my milling machine made of an old machine slide, **Fig.16**.

The Shaping machine

The weakness of the planer was the need to reciprocate the heavy table even when machining quite small components.

James Nasmyth, whose firm made a wide range of engineering products including steam engines and machine tools in the 19th century, was responsible for many inventions, few of which he patented, relying on his reputation for protection. One of these was his 'Steam Arm' of 1836 which he referred to as 'a planer' but was soon to be known as the shaping machine. It was described in his autobiography published in 1883 and is illustrated in **Fig.17**.

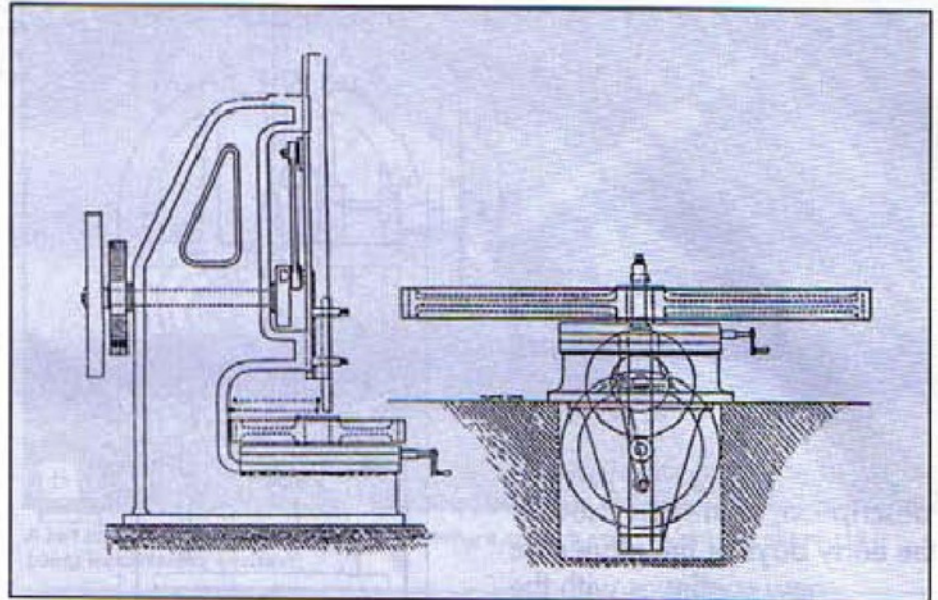


Fig.13: Nasmyth's slotter for large wheels, 1836, from James Nasmyth, his autobiography, 1883.

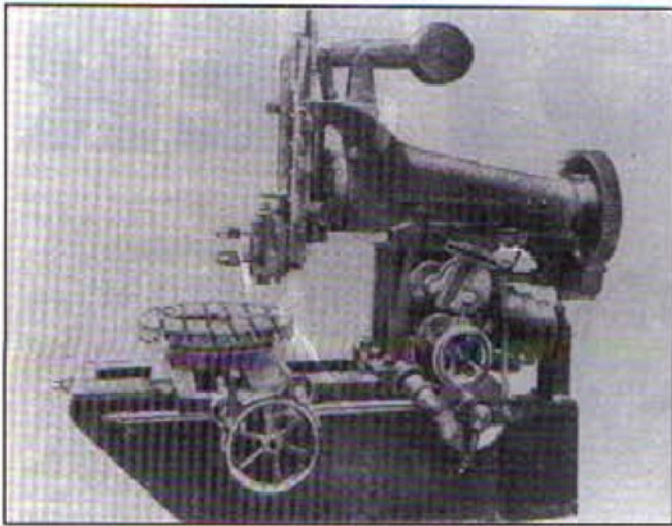


Fig.14: Dill movable head slotter, Alfred Herbert Cat. 1917.

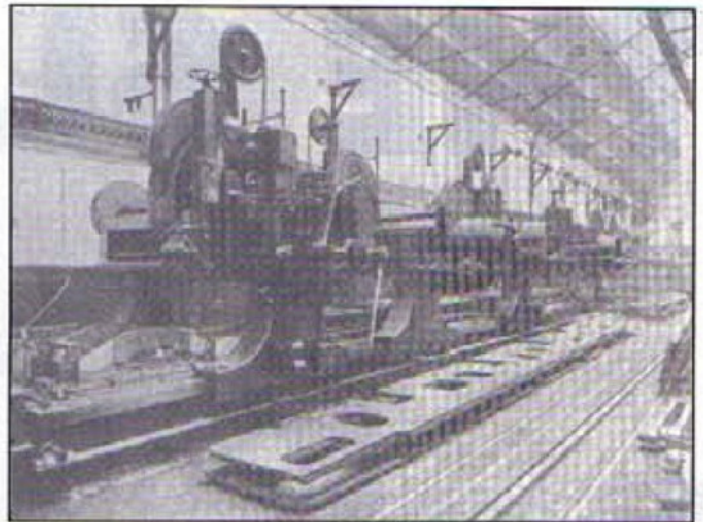


Fig.15: Locomotive frame slotting, Railway Gazette, 1929.

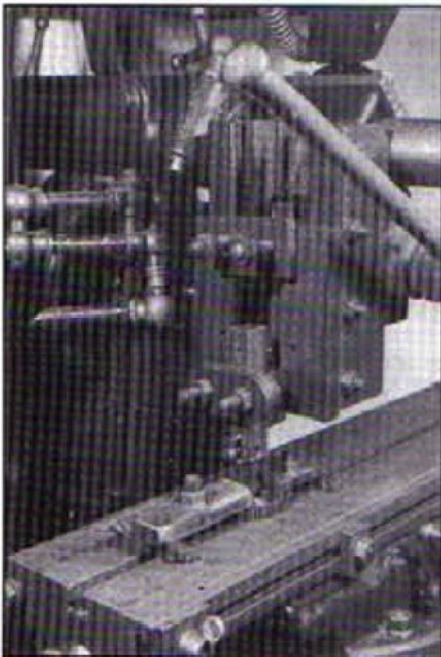


Fig.16: Slotting attachment on the author's milling machine.

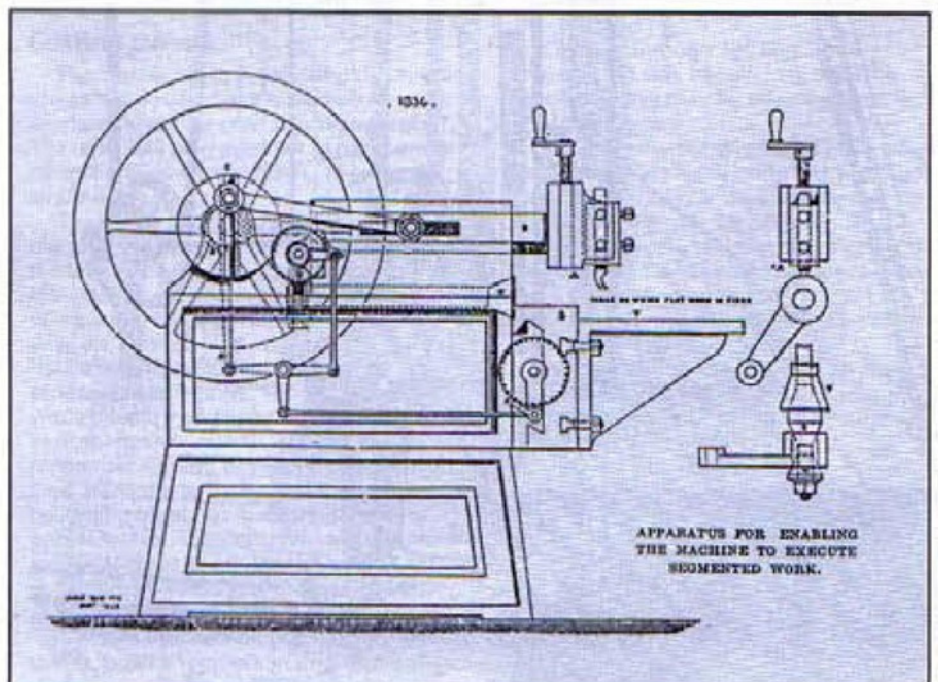


Fig.17: Nasmyth's 'Steam Arm', 1836. Nasmyth, 1883.

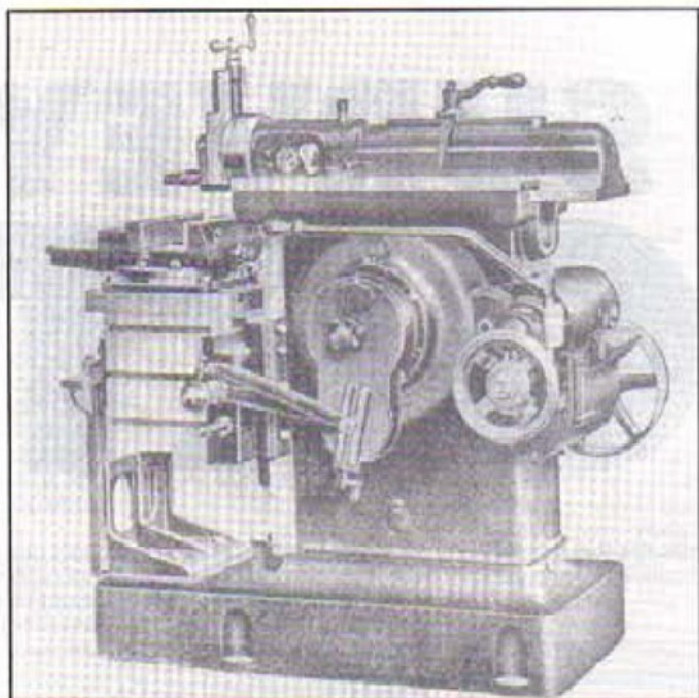


Fig.19: 32in. stroke fixed head shaper, Alfred Herbert Cat. 1917.

Instead of the work being traversed back and forth under the tool, this latter was held on a horizontal reciprocating ram, the stroke of which could be adjusted to suit the surface being machined. The work was held on a table supported on a slide at right angles to the ram movement and traversed incrementally at each cut by a feed screw. The tool holder was on a slide to enable the depth of cut to be set and had a clapper box to give relief on the return stroke. Although not on Nasmyth's machine this slide was soon given angular adjustment to enable angle faces such as dovetail slides to be machined. Fig.18.

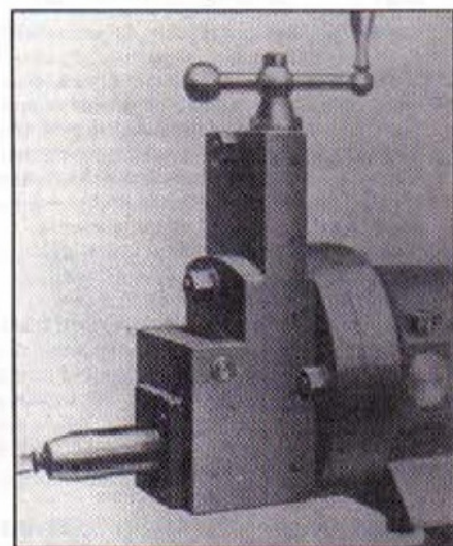


Fig.18: Shaping machine tool head, c.1930.

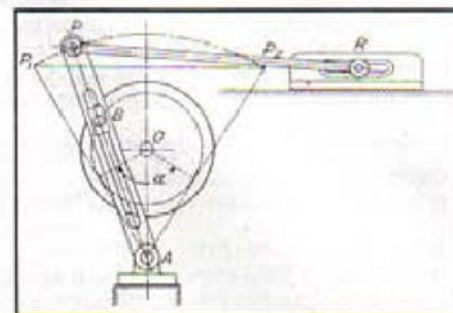


Fig.21: Whitworth's quick-return motion.

Two types evolved, the fixed head, essentially the Nasmyth form, in which the feed traverse was given to the work table. Fig.19 is a 1917 machine of this type. The other was the sliding head type, possibly developed by Whitworth between 1840 and 1850, in which the whole reciprocating ram slide assembly was moved across the work, Fig.20. For the fixed head type Whitworth developed a quick return motion, Fig.21 which was fitted to a machine being shown by him at the 1851 Exhibition.

As with the planer later improvements were in detail and size, a heavy 32in. stroke machine of 1917 has been shown in Fig.19. Attachments became available for various purposes such as rack and gear cutting, even a device to generate bevel gears, Fig.22. Generally for larger machines the fixed head type became most popular although all forms of planer and shaper have declined in numbers in recent years, largely due to the increased output possible on the milling machine. However for the smaller machine the sliding head remained more usual as can be seen by the Tom Senior machine of 1939 in Fig.23 or

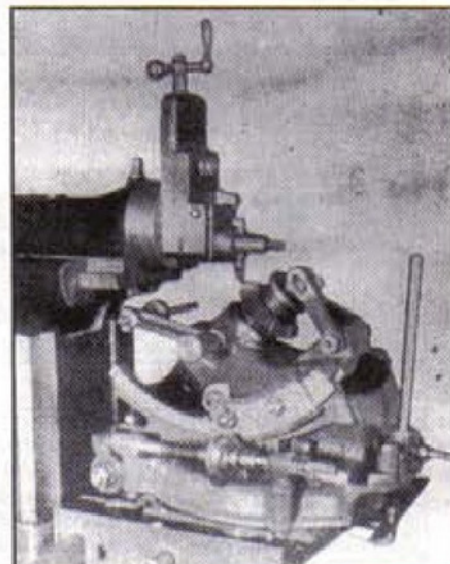


Fig.22: Bevel gear shaping machine attachment, c.1930.

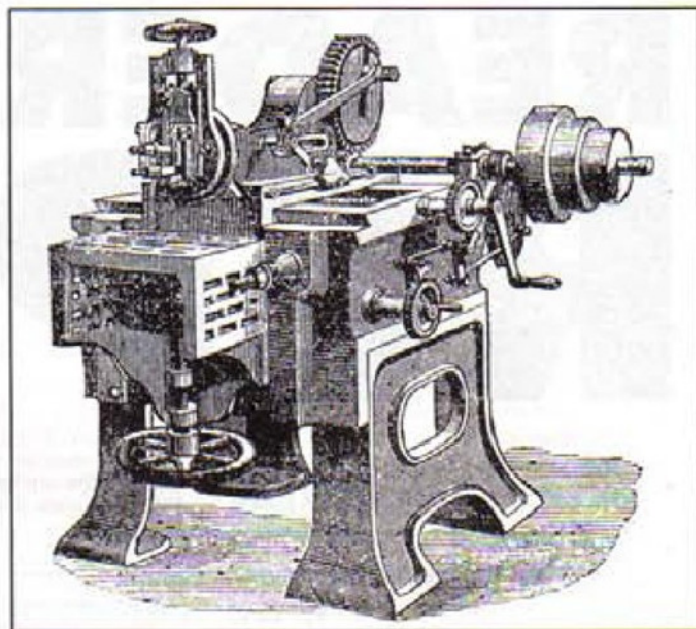


Fig.20: Sliding head shaper, 1858.

the No. 2 Adept Fig.24. I bought one of these in 1936 for £5.16s.6d (£5.82.5p), adapted it to do many varied jobs and eventually sold for £12.10s. (£12.50) in 1956 to pay for the scrap milling machine I was buying.

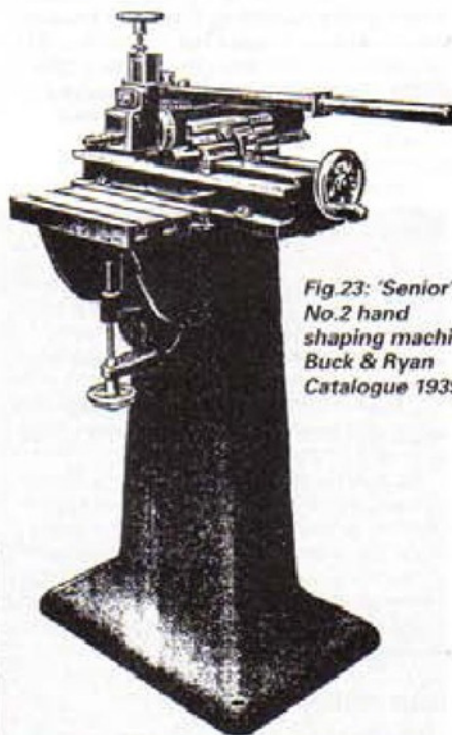


Fig.23: 'Senior' No.2 hand shaping machine. Buck & Ryan Catalogue 1939.

THE IMPROVED BENCH HAND SHAPER

	No. TENG3	No. TENG2A
Length of Stroke	10	10
Length of Cross Travel	1	2
Table	4 1/2 x 4	9 x 8
Rise and fall of Table	3	4
Maximum Distance between Tool and Table	1	6

Price:
No. TENG3 £3 17 6
No. TENG2A 5 10 6



Fig.24: 'Adept' No.2 hand shaper, Tyzack's Catalogue, 1936.

READER SURVEY REPORT

The following details the most interesting aspects of your replies to the recent reader survey.

The reader survey in the June/July issue No. 17 was the third since *M.E.W.* commenced publication. The one published in the first issue was obviously to find out about you, the readers, and what you would like in future issues of the magazine. When the second was published in issue No. 7 (Oct/Nov '91) we asked for your thoughts on the content of the magazine. When the third survey was published, the questions followed closely on the pattern of those in the second survey.

It would have been understandable if readers, having completed the earlier one, refrained from returning this latter survey. It was therefore very gratifying when to date, the number of replies is more than 30% up on the previous number. The earlier survey had also indicated that reader satisfaction with the magazine was high, so it was very encouraging to find that even this level of satisfaction had noticeably been improved on, more about that later.

As may be expected the answers to some questions have not greatly changed from those resulting from the last survey, hence I do not intend to go into the detail given in my report about that survey. This was published in the Feb/Mar issue, No. 9. Some readers may care to refer back to that report.

Your replies

Questions 1, 2, 3, & 5 showed almost identical results to those in the previous survey, though there was a small reduction in the number of readers attending evening classes; is this due to a reduction in the number of colleges offering such a facility, I wonder?

Question 4 indicated that 17% of readers belong to some engineering based society, typically vintage transport restoration, this compares with 23% belonging to model engineering clubs.

Question 6 gave the results below, the question did ask for the main activity but some readers ticked more than one so the mathematics do not add up. A quick flip

through the replies indicates that around 15% of readers ticked only workshop equipment.

Main workshop activity:	
Engineering models	43%
Other models	15%
Clocks	34%
Vintage transport	10%
Workshop equipment	63%
Other	19%

Of the 19% who ticked others their explanations were, as one would expect, very varied, most with just one such reply. Amongst items that received a number of replies (1 - 3%) were repairs, DIY, car/motor cycle maintenance. Other items with more than one reply but less than 1% included, aids for the handicapped, telescope making, musical instrument repairs and even flute making. Those with just one reply included earth moving machines, trams, canal boat parts, dental equipment and many, many others.

Question 7, this shows from the following answers, that much time is spent making workshop equipment.

Percentage of time spent making workshop equipment if this is a secondary interest:

Less than 10%	17%
11 - 30%	37%
31 - 50%	18%
More	4%

Question 8; as one would expect, this indicates that the time spent in the workshop varies considerably from one reader to another.

Hours spent in workshop per week:	
Less than 5	10%
5 - 10	34%
11 - 15	11%
16 - 20	16%
More than 20	15%

Question 9. This for me brought one of the most surprising results, 15% of readers had made the purchase of a lathe or milling machine in the last year, this figure rising to a very high 40% in the last three years.

Question 10. Top of the list for the next most likely major purchase was a milling machine, 25%, followed by a lathe 8%. This list was also long and varied, a few of the more unlikely items were, a plasma cutter, security system and slip gauges.

Question 11. When money is taken out of the equation, the most likely reason, by far, for not purchasing a major item of equipment is lack of space, a problem for 57% of readers. Being unable to move heavy equipment is a problem for 11%, inability to find product to exactly meet ones requirements is the reason given by some 6%.

Question 12. This was wrongly worded and I do not intend to comment on this question.

Question 13. This question was an exact repeat of a question in the previous survey and the following lists the results this time, with the last results quoted in brackets. These figures indicate that reader satisfaction with *M.E.W.* has improved since the last survey. The quite severe criticism made by a small number of readers in the previous survey have almost totally disappeared, only two readers considering the magazine to be fair or poor in all five categories, of course it could be that those who were not happy with the magazine in the past are no longer reading it.

The number of readers comments were few, and only a very small number came up more than once, four readers considered that there were too many mistakes in articles whilst five readers made the same point about drawings. I will not comment further as to some extent the answers overlapped with those given to Question 41. The figures for poor were in all cases less than 1% but even at this figure numbers were lower this time round.

	Very good (40%)	Good (51%)	Fair (5%)	Poor (0%)
Types of articles	58%	36%	3%	0%
Balance between complex/simple articles	(28%) 34%	(57%) 51%	(11%) 10%	(0%) 0%
Quality of articles	(41%) 52%	(50%) 39%	(6%) 4%	(0%) 0%
Quality of drawings	(33%) 48%	(52%) 42%	(11%) 6%	(0%) 0%
Overall quality	(50%) 67%	(44%) 29%	(3%) 1%	(0%) 0%

Question 14. Views on specific articles were requested in this question and was to me the most informative. Not surprisingly the results varied widely from article to article. Looking at the down side first, only two articles had around 40% of readers finding them not interesting, one other had 23% and the rest were between 2 and 13% with most being in the order of 2 - 3%.

Looking now at the other end of the scale, one article came out way ahead in the very useful category and that was milling for beginners with 47%, the next being 30% for the D.T.I. accessories. However, if we lump together the scores for very useful and useful, a slightly different picture results, the following are the top eleven.

1	Reamers and reaming	78%	
2	Milling for beginners	77%	
3	DTI accessories	76%	
4	Toggle clamps	75%	(304 readers)
5	Drills and drilling	75%	(302 readers)
6	End mill sharpening jig	75%	(302 readers)
7	Centre finder	67%	
8	Parallels	62%	
9	Improving milling vice	60%	(244 readers)
10	MIG and Arc welding	60%	(242 readers)
11	Hole gauges	60%	(242 readers)

The question as to which other articles have been particularly useful provided in excess of 100 replies, this probably means that almost every article gained at least one vote. There were a few articles which gained a number of votes and three were particularly well received. These were the *Tool and Cutter Grinder* (issue 16) with 6% the series on *Electric motors* 5% and the *History of Machines* series with 3%.

Question 15, relating to various features of the magazine indicated that **Scribe a Line** is very well liked with some 85% considering this to be either very interesting or interesting. Even supplier visits at the other end of the scale is liked by 70%. The following are the answers given.

	V. interesting	Interesting	Acceptable	Not at all interesting
Scribe a line	57%	38%	2%	0%
Quick Tips	52%	36%	8%	1%
Reader visits	31%	39%	22%	4%
Supplier visits	27%	43%	21%	5%
Trade counter	37%	45%	12%	1%
Product reviews	41%	39%	8%	1%

Question 16. The high photographic content of some articles is also well liked with some 65% finding it very useful and 24% useful, only 3 readers found it unacceptable.

Question 17. This provided a list of more than 160 items quite a few of which are typical of those already being published, such as the ten readers requesting lathe accessories. There are many new ideas and these will all be considered.

Question 23. Top of the list for other interests was woodwork with 47%, followed by electronics 32%, computing 26% and clocks 22%. The figures for

electronics and computing are particularly interesting. It would have been interesting to have found out how many have access to a computer at home, 26% at least it would appear.

Questions 27 and 28 together indicate that around 50% have, or have had, an engineering or technically orientated occupation. The list of other occupations is very wide ranging, here are but a few: Builder/decorator, teacher, anaesthetist, veterinary surgeon, surgeon, hotelier, lighthouse keeper, and many others.

Question 41. This in part overlapped with requests for comments in other questions, typically question 13. Very many comments were made but the overriding one was: Its very good keep it as it is. There are contradictory requests, such as: make it monthly/do not make it monthly, make all drawings metric/keep it Imperial, bring back Stan Bray (2 readers)/it is better with the present editor (1 reader), more articles for the beginner/more demanding articles (though in this case those calling for more for the beginner far outnumber those requesting more demanding articles).

Some non conflicting requests were received from a small number of readers, typically, separate ads from the articles 3% (This is being done. To be exact, one reader did say keep them as they are), free private ads for low cost items (*This also is being done, see Link Up*) Better proof reading, and examples from a single reader are - find another G.H. Thomas (*anyone care to act as scout? - Ed.*) less woolly editorials (*ouch - Ed.*), more photographs of the assemblies.

Conclusions

Without doubt the most frequent request, albeit stated in different ways and in answer to different questions (mostly 13, 17, 26 and 41) is the desire for more articles to suit the needs of the beginner, and those with limited time and equipment. The success of the *Milling for Beginners* article would appear to reinforce this request. As a result of this I will attempt to produce a comparable article aimed at using the lathe.

A small number of readers are obviously unhappy with the number of errors which appear in the magazine and every effort is being made to minimise these. A few still refer to errors in the drawings and I do wonder if they are still being influenced by the standard of drawings a few issues back. A considerable effort has been made to limit these errors and it would be less than honest of me to guarantee to do better than is being achieved at the present, that is not to say that I will not continue to try.

About us

Having received and analysed your replies to the Reader Survey, for which I am very grateful, I feel it would not be out of place to tell you a little about this side of the operation.

Firstly, as the magazine is a relatively low circulation periodical it is of necessity run with a limited budget, so let us talk of the personnel involved. Starting first with the authors, these are largely new to the task having responded to the request made in earlier copies of the magazine. A few

have provided articles for other magazines, but even so are to my knowledge all amateurs as far as article writing is concerned.

I count myself in this band, although I am now paid for the job, and therefore suppose must be considered a professional. I still have much to learn when it comes to writing the articles that I provide; generally those without a name of author.

In fact many authors are not even from an engineering background. Mr. Brooks who provided the very successful *Cutter Grinder* article is a painter/decorator with only some seven years experience with a home workshop. Many others come from a similarly non engineering background.

The articles once submitted to me (Ed.) are then checked by myself and in almost all cases the drawings are then, after my adding any extra views, notes, corrections etc., even converting some articles from Imperial to metric to satisfy that need, are sent to a tracer for drawing. A draughtsman is available for the centre fold.

A professional photographer is available, but as this necessitates visiting the reader or supplier first and then returning with the photographs, I normally take the photographs myself on my first visit.

When the articles have been finalised for a given issue, I pass them onto to Argus Specialist Publications who add the advertisements. Page layouts are then established by them when some additional proof reading is also done, followed by arranging printing and distribution.



Notes for authors

I am in the course of producing some more detailed suggestions for authors submitting items to *M.E.W.* These do not in any way make the requirements more complex for the author, but are aimed at making the project flow more easily and with less errors. Typically a request for authors to spread their drawings over a wider area, so that there is more room for me to add further views or notes prior to the tracer re-drawing. Anyone who considers they may like to provide an article or two for publication may request a copy of these notes. Existing authors will receive a copy automatically.

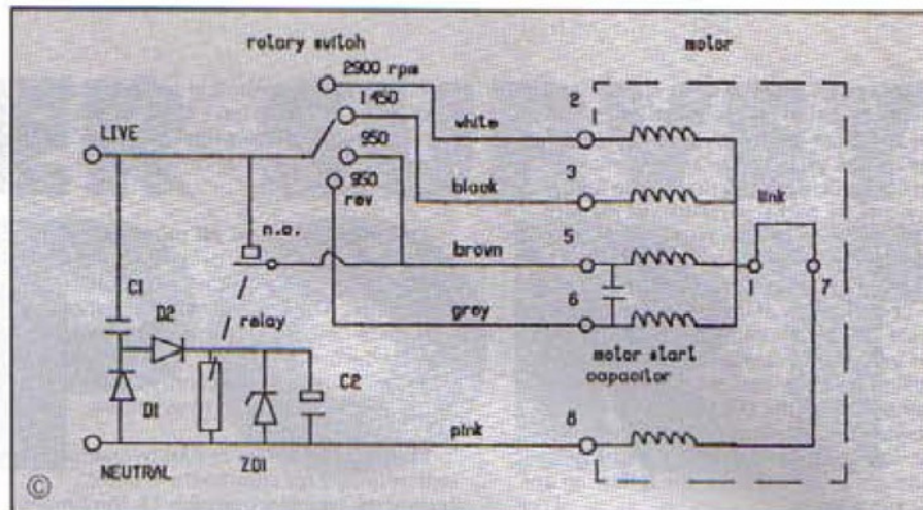
Once again many thanks to all readers who returned survey forms, your interest in assisting the magazine in this manner is much appreciated.

QUICK TIP

In the home workshop do not cool high speed steel drills in water after sharpening. These drills should be ground dry and allowed to cool in air. Quenching can cause hair line cracks to occur on the surface of the metal. There is no danger of drawing the temper of high speed steel by the heat generated on a grindstone.

Alan Jeeves

A lot of readers showed interest in the Zanussi z900 electric motor which was mentioned by Les Rix in Scribe a Line in our last issue. Some have managed to acquire the motor and are at a loss to know how to connect it correctly. If you are one of the fortunate individuals who have obtained such a motor the following instructions will be of use to you



USING A SURPLUS MOTOR

The Zanussi z900 series of washing-machines and dryers are now obsolete. They may be found at the local dump, or stripped for spares at the local repairman's graveyard. The machine used a 3-speed induction motor which is ideally suited for machinery drive in the home workshop. The two units I had were made by Sachs and drove the output pulley drum at nominal speeds of 280, 950 and 1480 rpm. The lowest speed is a 10:1 reduction from 2800 rpm; the epicyclic reduction drive engaged by a centrifugal clutch only operating at the higher rotational speed.

After a year of fathoming and despite the utility of a 280 rpm source to drive the Dore-Westbury miller the clutch and roller assembly was discarded and the motor shaft hacksawed to a reasonable length. (Abandoning the clutch drum etc. was a good move; the low speed was undoubtedly worthwhile, but the overhung shaft and the difficulty of fitting a top-hat stop-pulley posed problems).

The original washing machine controller and circuit were obscure and so with an Ohm-meter, a "true" power meter, a stall-brake, and one-hand working at a distance (!) a scheme for use was developed.

The motor is fan-cooled and mounted by long bolts through rubber sleeves in the alloy frame - these may conveniently be bracketed to a Myford motor-plate or arranged as swivels if required. When installing the motor, ensure if possible that the 8 μ F start capacitor, the power plug and a few feet of wiring harness are collected. If a DIY job is necessary make sure a safe harness is wired, preferably colour-coded, and a suitable capacitor used. The latter might be scrounged off a large fluorescent fitting. Needless to say: the motor-frame and any metalwork associated must be earth-bonded.

To furnish the 3-speed facility with reverse (in all speeds e.g. my 18-speed forward-reverse ML7, if really enthusiastic) a small control-unit is fitted between the conventional machine starter (no-volt release/thermal trip) and the motor.

Full details of the speed-switch are attached but the unit should be built into an

earthed metal box or fully insulated within a heavy-grade plastic switchbox - ensure earth continuity in this latter provision. The rotary switch is rated for changing speed with the motor under power. Use of this is not really advisable; changing from forward to reverse rotation whilst operating will have no effect except on the slowest speed, and the capacitor may suffer.

Braking of the motor to speed "dropout" point indicated the following:
RPM 2900 Power 0.5 hp Current 1.9 amps
RPM 1450 Power 0.35 hp Current 1.5 amps
RPM 950 Power 0.26 hp Current 0.9 amps

In practice these power deliveries do not pose limitations although it is possible to juggle speeds and reduction gearing to accommodate light and heavy work. Suffice to say that light feeds or coilwinding at 950 rpm is blissfully peaceful, necessary at midnight, and wind-back when screwcutting is at the flick of a switch.

Speed options for power and/or torque variations

Mandrel rpm	Motor rpm	Ratio	Gear
36	950	L	BG
320	1450	L	S
56	1450	L	BG
355	2800	H	BG
64	950	H	BG
375	950	M	S
100	1450	M	BG
570	1450	M	S
112	2800	L	BG
640	2800	L	S
116	950	H	BG
670	950	H	S
180	1450	H	BG
1020	1450	H	S
200	2800	M	BG
1140	2800	M	S
210	950	L	S
2050	2800	H	S

Ratio: Low, Medium, High, is the option on the mandrel pulley

Gear: Is Straight or Backgear

The diagram and legends refer to the harness etc. which was fitted by the makers. Below I give a list of components required for a DIY job.

Components

C1 1 μ F 250v a.c./400v d.c. polyester capacitor, Maplin ref. JR37S

C2 220 μ F 35v d.c. electrolytic capacitor, Maplin ref. FB62S.

D1,D2 1N4006 rectifier diode Maplin ref. Q178K.

Z1 Zener Diode 24 v 1.3 W Maplin ref. QF625

Relay 12v D.C. 5A mains-switching Maplin ref. JG66W

Rotary Switch 2 pole 6 way Maplin refs. FH46A + FH48C (standard configuration - poles can be paralleled to increase current rating or use spare tags to anchor components)

The component listing is for ease of sourcing items. RS Components or surplus items may be applicable.

Principle of operation

The motor configuration comprises a centre-tapped winding on a 6-pole stator to give a loaded speed of 950 rpm. The centre-tap links to Neutral through a further winding section. A phase-lag capacitor bridges the ends of the winding and depending on which end is linked to Live the motor rotates either way and self-starts. The winding then serves as bidirectional starter for the 4-pole and 2-pole high-speed configurations. To improve efficiency and minimise magnetic noise the starter is best disconnected when running at the higher speeds. Capacitor C1 reduces the mains voltage which is rectified by diodes D1,D2 and smoothed and regulated by C2 and ZD1. At switch-on C2 charges relatively slowly and it is perhaps 1/2 second before the relay pulls-in. This opens the initially closed contacts feeding power to the "forward" power-lead of the 950 rpm/starter unit and run-up to selected speed occurs.

In "reverse" there is initially balance-stall of the forward, and reverse winding sections then forward disconnects and reverse running occurs. Components are not critical and the value of C2 may be altered to compensate various relays for switch-on lag including 24 volt units.

Maplin Electronics, PO Box 3, Rayleigh, Essex, S.J6 2BR. Tel. 0702 554161. Fax 0702 553935.

SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in *Model Engineers' Workshop* are always welcome

Aluminium alloys

Some interesting comments from Robert Turner of Edinburgh, obviously one of our younger readers.

I am writing in reply to Mr. M.S.

Atkinson's request for information about aluminium alloys. I am by no means an expert in Engineering alloys, all of my knowledge on this topic comes from an excellent catalogue.

It seems that from the beginning it should be made clear that terms such as Duralumin and Hiduminium are no longer really used in industry, as there are now at least 25 different alloy designations; the old B.S. Alloy designations such as HE15 and HE30 are technically obsolete. The ISO 4-digit reference number now defines all of the aluminium alloys by general groups. The most commonly available group of alloys (and the only group generally stocked by specialists) is the 6xxx group, which are Heat-Treatable magnesium/silicon alloys, especially 6082 which is the old H30 alloy - good for machining and MIG/TIG welding, and the lower-strength 6063. After the 4 figure number is the Heat-Treatment state of the alloy - usually T3, T4 or T6 - the last being the strongest.

Aluminium and its alloys are a very complex area, especially for home engineers, where they have a relatively small application. The area is further complicated by the difficulty of obtaining exactly the right alloy in the right size. My recent experience is from buying stock with which to build a bicycle. I could only obtain a slightly odd mix of metric and Imperial sizes (of tubes, in this case) and couldn't obtain all of the 5 different tube sizes and 2 plate thicknesses in exactly the same alloy or heat-treatment state. However, for a young amateur (soon to turn professional) light engineer such as myself, Aluminium is wonderful stuff - it is strong, lightweight and amazingly easy to fabricate - cold forming, cutting etc. and it can be satisfactorily welded with good amateur equipment. Heat-treatment, however, is in the 'don't try this at home' category.

On a different (but connected) note: As already mentioned, I consider myself a Light/Precision Engineer, although a real beginner as far as machine tools are concerned. Being born in the week that steam finally disappeared from British Railways, I have no experience, and not very much interest in the heavy steam bias to the model engineering field. My own projects recently include a field camera for 5 x 4in. (designed, but not made, by me) and the recumbent bicycle mentioned above. My point is, is there a possibility of further expanding the scope of your magazine to a more general 'Home Workshop' outlook? (Sorry Robert but most readers appear to want it to stay much as it is at the moment. Is there a case for a magazine such as *Practical Mechanics* which was mentioned in our last issue? Ed.)

I am sure there are plenty of people in your potential audience who simply make

or restore things. Don't infer any criticism in the above - yours is a fine magazine, and I enjoy it a great deal, especially now that I am starting to set up a workshop for myself (tricky that, in a 4th floor Victorian tenement flat, but I must persevere).

Locknuts - a myth refuted - and other matters

From G L Luscon-Jones of Gloucester. Scribe-a-Line, April/May issue, letter from R. Fuller of South Africa. Item 6 of this gentleman's letter regarding the location of locknuts is, I am sorry to say, erroneous. His description of the assembly is almost certain to be derived from engineering text books which were current in my youth, and perpetuated a passage in a book published in the 1890's. This book, by a Professor Law had sectioned drawings of a stud or bolt, with a locknut topped by a full nut, showing the full nut carrying the load. My Father and later the Foreman Millwright of the Company to which I was apprenticed proved to me, by use of models, and an explanation of the stretching of a bolt or stud, and the compression of a nut when the two items were tightened that this was not the case. I believe that Tubal Cain published some photos of a model, further disproving the original statement in an issue of *Model Engineer* during 1990. (There are several references. Tubal Cain dealt with the subject quite exhaustively in M.E. 20 April 1990 and 1 November 1974, and M.E. for 18 May 1990 carried further letters on the subject from other readers - Ed).

In page 7 of S.A.L., same issue, James Hartinger enquires for information on the extraction of very small screws. Depending on how small, what material, type of hole, (through or blind) type of break, (flush or proud), perhaps the following may be of use:-

1. If break is flush, or nearly so, file flat, centre punch accurately and drill with a series of drills, increasing in size until a thin shell is left in the hole. This shell may then be collapsed by careful use of a sharp pointed tool and a light hammer.

2. Drill a small hole as above, drive a file tang into the hole, (not the hard bit) and apply a suitable gripping tool to the tang, i.e. Mole grip, small tap wrench etc. and attempt to screw out.

The application of a penetrating fluid and a gentle heating of the broken piece and its surround may be of help when attempting to remove by unscrewing.

3. If the broken item is proud of the surface it may be possible to file a small square to provide a gripping area, or to cut a slot for a screwdriver into the offending item. It may also be possible to cut a slot as before, insert a suitable piece of metal to form a key handle and use this to unscrew the broken screw.

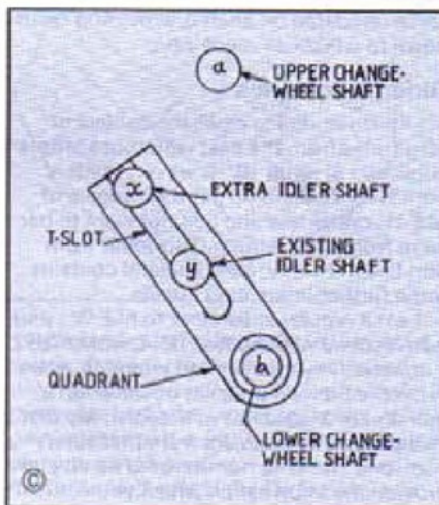
I hope some of the above may be of interest.

(For copies of Tubal Cain's letter and the other references to this subject, send to Photostat Service, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST, quoting the references above).

Left hand threads - Warco 918 lathe

Dick Guntrip of Helston offers a method for producing the occasional left hand thread on a Warco 918 lathe

Whilst trying to devise a method of reversing the leadscrew on my Warco 918 lathe, I was referred to Mr Weight's article in the 1.1.93 issue of *Model Engineer*. Thinking about that scheme, I was unhappy about deleting the plastic safety gear from the headstock train. It seemed to me possible to produce a tumbler reverse which would not only keep the plastic gear in circuit for both forward and reverse, but also require only one new gear wheel instead of three. Although my scheme is intended to make maximum use of 918 spares (building equipment is not really my hobby), it will still take me some time to complete.



However, if the need for leadscrew reversal is really just to make the odd L.H. thread, the following is a cheap and cheerful way of getting the 918 to cut any of its listed Imperial thread TPI's left handed.

The standard machine has a single moveable shaft in the T-slot of the quadrant which carries the 120 and 127-tooth wheels. Combined, they do the Metric conversion but for Imperial threads only one is in circuit, acting simply as an idler. If a second shaft is fitted in the T-slot and the two large gears deleted in favour of more modest sizes, the rotation of the leadscrew is reversed. On the machine's screw cutting table, the top and bottom change wheels are referred to as a and b respectively: if the two intermediate wheels are called x and y, the layout of the shafts are as shown in the sketch.

Permissible wheel sizes (in numbers of teeth) appear to be:

(i) For x to be safely seated in the end of the T-slot, $x/2 + y + b/2$ must not be greater than 100.

(ii) For x to be able to mesh with a, $a/2 + x + y + b/2$ must not be less than 143.

There is no need for any more wheels than the standard set to achieve all the TPIs listed: suitable sequences are:-

TPI*	8 - 14	16 - 28	32 - 56
a	60	30	30
x	80	80	80
y	36 or 42	36 or 42	28 or 30
b	30	30	60

The only parts needed are a second complete sliding shaft assembly comprising one each of:

Name	918 Part No.
Bush	0012
Slip Washer	0014
T-Nut	0048
Washer	0049
Shaft	0050
Oil Feeder	— 3/4 inch
Spacing Ring	0059 Optional for shaft y
Alternatively fit	
28 tooth gear as spacer outside working gear.	
80 tooth gear on shaft x does not need spacer.	

All parts on this list can be obtained from Warren Machine Tools (Guildford) Ltd.

Finally, I do not know if it is generally realised that the 918 is capable of producing several more whole number TPI's/thread pitches if wheels other than 30 and 60 are used on shafts a and b; also that if the lower flange of the door is relieved slightly, even the 120 tooth wheel can be accommodated on shaft b, providing feeds down to 0.0025in./revolution.

Older magazines

I had intended to close the subject of magazines from the past with those letters published in issue 18. However, readers from New Zealand do get their copies of M.E.W. rather late and I do not want to bar them from contributing. This letter from Don Lee of Huntly, New Zealand contains some further interesting details.

I am a regular subscriber to M.E.W., and was recently reading No. 16, Apr/May 1993. It attracted my interest and attention when in On the Editor's Bench, you included a mention of *Magazines of the Past*. My first thoughts on this subject were that surely someone closer to home would be able to provide the information which you requested.

On second thoughts, I decided that just in case no-one answered your request I would write and give you particulars relating to English Mechanic and World of Science; as I have had a special interest in this particular magazine for the past 35 years. The information which you are seeking is as follows: English Mechanics, as it is usually referred to was first issued on March 31, 1865, in Queen Victoria's reign. Its first full title was The English Mechanic, a Record of Mechanical Inventions, Scientific and Industrial Progress, Building, Engineering, Manufactures and Arts. It was priced at 1d weekly.

By the time Vol.4 was issued in 1866-1867 its title had been shortened to English Mechanic and Mirror of Science and Art; but by 1870 with Vol.11 the word Art was dropped and it became English Mechanic and World of Science. The complete title was retained in this form until issue No. 3212, 22 October 1926, following which it then had a further shortening of title to English Mechanics. A new series was started at that time with Vol.1, October 29 1926. This new shortened title was continued again until the magazine was changed to Mechanics with Vol.32 in 1942.

English Mechanics finally became incorporated with Model Engineer in March 1959 after a run of 94 years.

I have enjoyed reading through very many volumes of English Mechanics over many years, beginning in England with a special interests in such subjects as lathes, and other machines; this magazine provided a wealth of information. The issue which you have quoted as being dated

October 2 1903, and issue No. 2010, photocopied by Mr Gould, is from Vol.78 of the old series.

Many of these volumes may still be available at good main libraries, especially in England. However, you may find that they will be "For reference only" and cannot be borrowed on account of their age. A few volumes are, from time to time, available for sale as "rare books" in England but are understandably quite expensive.

Finally, I sympathise with Mr Swingle (Issue No. 14, page 8, M.E.W.) as his Drummond lathe is a very old, early model with central leadscrew. Regarding changewheels for 3 1/2 in. Drummonds, I would agree with Mr Jim Mander (Issue 16 page 7). In the absence of 14 D.P. wheels, it may be best to purchase Myford 20 D.P. changewheels with a 1/2 in. bore. A Drummond set of 14 D.P. changewheels was as quoted by Mr Kennedy on page 10 of the same issue; but with the addition of one each of 46 and 73 tooth changewheels not included in Mr Kennedy's set. These were standard wheels supplied with a set by Drummond Bros., of Rydes Hill, Guildford.

Simple but effective!

Stan Hinds of Cook, Australia suggests a novel use for an electric screwdriver.

This may be of interest to you for Scribe a line.

When turning tapers, using the top slide, it is sometimes difficult to get a nice uniform finish when rotating the top slide handle by hand - the problem is described by the late Geo. Thomas in his book, The Model Engineers Workshop Manual, page 141. (TEE Publishing, price £19.95, plus p&p - Ed.)

My suggestion is to power drive the top slide using an electric screwdriver - cordless preferred. The traverse speed may be a little too fast for some lathe speeds, but the finish I get is better than any which I can obtain by hand.

On my Myford Speed 10 I removed the small handle for the top slide and replaced it with an internal threaded (for about 10 mm) piece of rod of suitable diameter. I forced a short length of thick wall flexible tubing over it and over the screwdriver bit. This tubing acts as a universal joint/vibration insulator and allows one to hold the screwdriver away from the tailstock. Clearly this idea could be used on the cross slide.

Incidentally, if the piece of rod, replacing the handle, is externally threaded at the other end the handle can be replaced. This gives an extension which can be useful where the top slide is angled and the handle is liable to strike parts of the lathe, even if used without the above power feed. When using the extension in this fashion remember that the rod will be fairly flexible, so try to support the rod with the fingers of the other hand, or turn very gently.

Re-cycling old containers

This letter from S. Rowe of Warminster. In the August/September 93 issue you featured an article on making oil cans from old film canisters. I have several home-made oil cans made from old Sarsons vinegar bottles and Heinz Ketchup bottles (plastic type). They both have screw tops which are easy to drill to take a spout.

Because they are designed to be squeezed, it is possible to use a longer spout.

Secondly, in the June/July 93 issue you had a letter from Mr V. J. Kelly who wanted to know about weather vanes. There is a very good book available called Weather vanes of Great Britain by Patricia and Philip Mockridge published by Robert Hale in 1990 (try your local library).

Another old magazine sought

Jonathan Cary of Bedford would very much like to see a copy of a magazine advertised in M.E. a long time ago.

Model Engineer, 23 Nov. 1939 contained an advertisement for Steam Car Developments and Steam Aviation - a magazine which is "working to make aviation safer and more reliable by developing steam aircraft". Now I would love to see a photocopy of one of these magazines.

(The copies of M.E. for 1939 in the office, were unfortunately bound excluding the advertisements. I would very much like to see a copy of the advertisement, or the book - Ed.)

A mystery resolved

From D. Dunnico of Manchester.

Re Mr. A Whittakers query in the Aug/Sept issue. The photograph is indeed of the 3 1/2 in. Drummond lathe. I have the self same model.

(My doubts expressed, were on the basis of not having seen in any article, advertisement or manual, for a Drummond lathe, an illustration showing the bridge cast across the top of the headstock - Ed.)

A timely idea

A suggestion from K.W. Sacre of Walkern.

In the American magazine, The Home Shop Machinist they run a column called Net Working whereby people submit their name and address and interests, inviting like minded engineers to contact them. (There is another column in an American mag. called Steamed Hams for those who combine amateur radio and small locomotives - Ed.)

Many useful friendships can be made and I feel that it would be useful to know that there is likely to be someone of kindred spirit, perhaps not far from you.

I feel that perhaps there is scope for a column like this in M.E.W.

(See details of our new feature Link Up elsewhere in this issue. -Ed.)

An anonymous ML10 gearbox

This interesting letter comes from V.A., a reader from Ballymoney, Northern Ireland, whose name unfortunately I cannot fully read. Please do print names in addition to signatures.

I have just completed a Norton type gearbox for my Myford ML 10 lathe, to a design similar to that published in your sister magazine for the ML7. All the work, including gear cutting was carried out on the ML10 which necessitated a few design changes. While not a simple task on the ML10, it is I feel, better to design within the capabilities of one's own machinery.

I have also recently completed a headstock dividing attachment to G.H. Thomas' design and a milling spindle to the design of Mr. Broadley. The materials

for both were bought from Hemingway of Rochdale, whose support has been tremendous.

These two items were united to provide a makeshift dividing head for the gear cutting operation. Has anyone else built such a gearbox for the ML10 I wonder? Or as one friend put it does anyone consider the ML10 worth the trouble. I certainly do, but am sometimes disheartened to see so many projects which need larger lathes and heavy milling machines.

I wholeheartedly concur with your views about amateur design, as the range of designs is as diverse as model engineers themselves. I would also support the idea of showing tools made, not to exhibition finish but rather to a practical standard.

Distance makes it difficult to show items in London but I for one would certainly try. Perhaps a certificate of display could be awarded instead of competition. (All exhibitors are awarded a Certificate of Acceptance - Ed.). I wonder how many good ideas are locked away in workshops all over the country? (See details elsewhere in this issue concerning a proposed M.E.W. display within the Loan Section at the forthcoming M.E. Exhibition. I have had quite a number of similar encouraging letters; please do not let me down. Ed.)

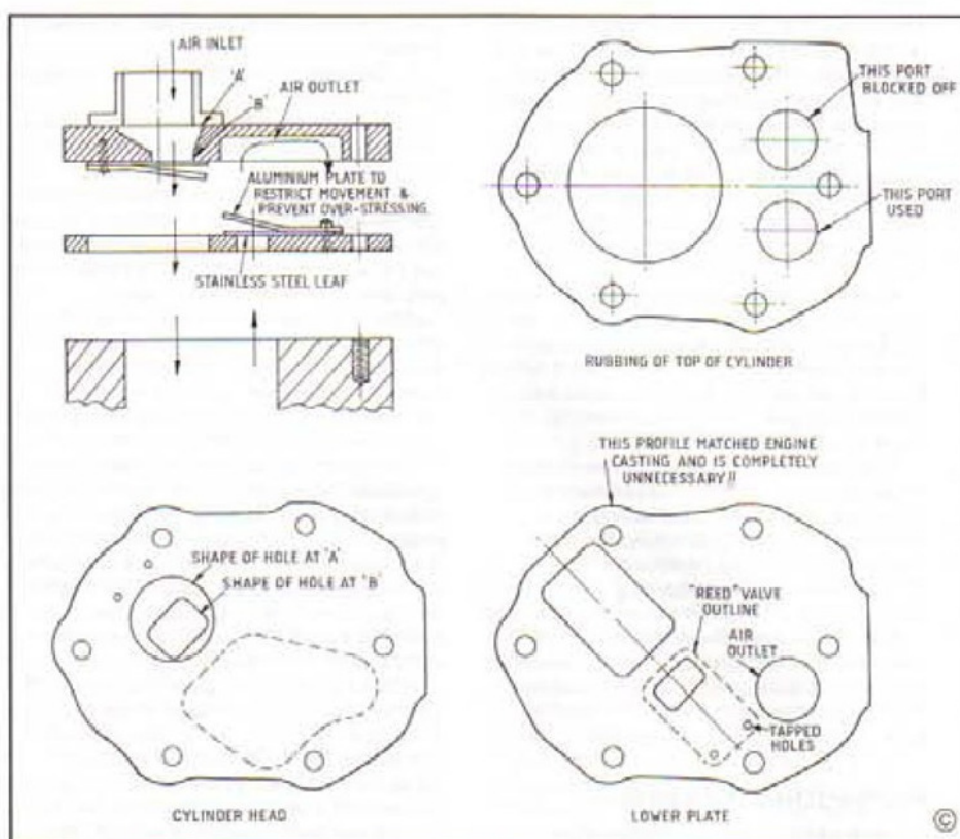
Finally like Derek Brooks, whose work is superb, I have had no formal training in engineering at all; so do encourage anyone to have a go. Practice makes perfect.

Band-saw mod.

The problem of cutting short pieces in the popular universal band saws available is obviously a common one. As a result, numerous ways of overcoming this are surfacing, this one from Cyril Drayton of North Ferriby.

Thank you for the Bandsaw Vice Improvement article. I had moved along similar but not identical lines. The additional fixed jaw idea had not occurred to me. I have now adopted it.

My method differs from the proposals in your article, in that the vice jaws have not been moved towards the blade in the manner suggested. Instead, new jaws have



been fitted within the existing ones. The new jaws consist of two steel bars, each $2 \times \frac{3}{4} \times 7\frac{1}{4}$ inches. On the centre line of one bar and $\frac{1}{4}$ in. from the end a hole was drilled and tapped to accept a M 10 screw $\frac{1}{2}$ in. long. Fitted is not quite the correct word; the bars just slot into position. The sketch illustrates the principle. The assembly can be slid forward to within about 1mm of the blade. The procedure is to close the vice until the work is just contacted. The M 10 screw is then screwed in until the new jaws become parallel, using an additional packing piece if necessary. Final tightening is by the handwheel.

Surprisingly small pieces of metal can be held and cut. In fact, so long as the work will bridge the gap between the fixed jaw and the additional fixed jaw it can be cut. If the piece is too small to bridge the gap in the bed it can still be cut by supporting it on a slip of scrap wood - 3 ply perhaps. The saw will then cut cleanly through the metal and into the wood. The vice opening is reduced, but by a fairly insignificant amount.

Favourable aspects of the method are its simplicity and effectiveness, the fact that no alteration to the basic machine is involved and that the components can be completely de-mounted in the time taken to unscrew the additional fixed jaw.

Compressor from i.c. engine

Following the article describing Geoff Walker's workshop, a query was received from a reader regarding Geoff's compressor, which was made from a lawn mower engine. This is the relevant part of his reply.

I would like to think that I could make this reply short, to the point and helpful but I have a feeling that I am going to fail on all counts!

The engine, a four stroke, is from a Suffolk Punch mower (the Colt has the same engine).

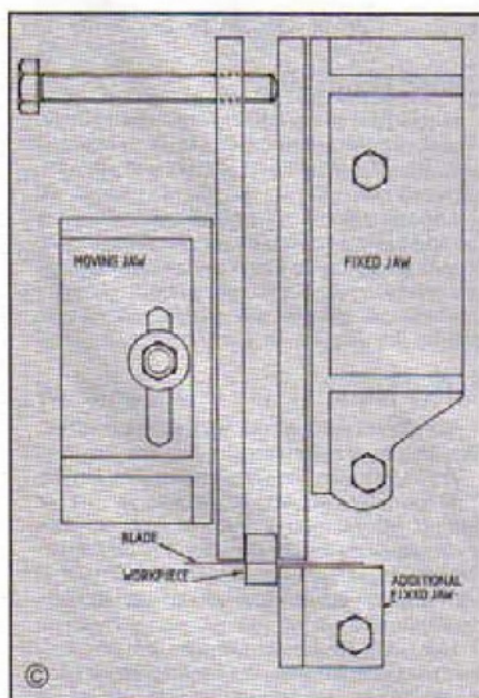
I discarded the cylinder head, camshaft, valves, flywheel/magneto etc. and used only the engine casing, base, crankshaft, piston and magneto mounting plate, which gave access to the crank, etc. and included one crankshaft bearing. I cut/machined all the unwanted part of the latter away and also removed the flywheel end of the crankshaft. I fitted a pulley to the other end in place of the clutch.

I made a rubbing of the top of the cylinder, copy enclosed. I used this to design the new cylinder head. This design was dictated by my machining capacity, which at that time consisted of a Myford ML10 and a pillar drill. Milling was my problem. I used aluminium, which I could mill on the lathe (using a vertical slide). I had this in stock and it would not rust.

Valves were the main problem. I had decided that I couldn't use the existing inlet or exhaust valves and settled on reed type valves as used on some motor bikes. At this point I had a bit of luck. I went to an exhibition and one manufacturer was showing small components stamped from thin, springy, stainless steel and had a tray of samples. I managed to find three suitable samples of one size (one as a spare) and these dictated the valve size. I think spring steel would corrode very quickly in this environment.

The new cylinder head consists of two pieces of aluminium sandwiched together; see the "working drawings", they were the only drawings I made for this job. The inlet used the existing air filter via a suitable spigot and the delivery was via an existing port (screwed $\frac{1}{8}$ in. BSP), the other being blocked off.

Now, how well does it work? I'm sure it is quite inefficient. I use a $\frac{1}{4}$ hp, 1440 rpm motor with a belt drive giving about a 2:1 speed reduction. The ex-factory air receiver (to which I welded a couple of extra bosses) is approximately 24×8 in. diameter. I have a pressure switch which is



set to cut off at 60 psi. How much higher it would go I don't know but I daren't risk the valves with only one spare. It takes about four minutes to charge the cylinder to this pressure. The valves leak, so when not in use the pressure slowly leaks away. I haven't found a suitable 1/4in. check valve. I would really like a solenoid valve arranged to open on switching on the motor and closing when the motor stopped. Again I haven't found a suitable one.

I use oil in the sump, so the delivered air is not oil-free. I have an oil filter with combined reducing valve so this can be turned down to give a lower pressure for blowing out swarf and set to the correct pressure for blowing up tyres and my neighbour's inflatable pool.

I don't think it would be oil-free enough to use for spray painting, but I haven't tried it. I find it very useful for cleaning blind holes during tapping; cleaning the taps themselves, cleaning holes when drilling/boring in the lathe, and other mundane jobs. I wouldn't be without it.

(Geoff also provided sketches of the overall and piping arrangements, these are not published with this letter. Any reader wishing to obtain a copy, please send a s.a.e. marked, Piping arrangement).

Footswitches and safety

Hans-Ulrich Dussel of Wuppertal, Germany, details this idea for improving the safety of a rotary switch started drilling machine.

The discussion on the subject of foot switches in particular (S.A.L. issue 18) and considerations of 'safety at work' in general have encouraged me to write a few lines. Quite recently I acquired an old but mechanically sound and well preserved pillar drill. As a drilling machine is considered one of the most hazardous machines in the workshop (mainly because the potential danger is not taken seriously) I wanted to update it to current safety standards.

A lever-operated switch built into the machine head is used to power the motor (and another two for the coolant pump and the light, which do not matter in this context). I did not want to change this construction, but I wanted a foot-operated emergency-off and additional protection against accidental restart after a power

loss. The required function was specified as follows:

- 1). Operate the machine normally using the lever switch.
- 2). If the power fails or the foot switch is pressed the motor should be shut down immediately.
- 3). Once off, additional operation of the foot switch should have no effect as should the return of the mains power. The machine can be restarted only by switching the lever switch to Off and then to On again.

After a little consideration I found that this could be achieved quite easily. The attached circuit diagram shows that an auxiliary relay A with a single normally open (N.O.) contact is needed plus a power relay B with 3 N.O. contacts rated suitable for the motor (or just one for single phase operation). Also needed is a foot operated momentary (non-latching) switch with a single N.C. contact. If the main switch SW1 is single pole, double throw, this is alright to use. Mine was three pole, single throw, so I had to replace it (it is still a lever operated switch built into the head; there was no need even to drill new holes).

When the main switch SW1 is in the Off position the auxiliary relay A is energized through SW1.2, SW1.1 and the released foot switch SW2. Once excited relay A holds itself through a 1.3/a1.4 contact. If the foot switch is operated now, relay A is off as long as the foot switch is pressed and goes on again on its release; no further effects occur. When the main switch is turned On B relay is energized through a1.3/a1.4, SW1.1 and SW1.4 contacts and starts the motor (set of b contacts). Returning SW1 to the Off position de-energizes B relay, thus stopping the motor.

When the motor is turning and the foot switch is pressed or the power fails, the auxiliary relay A is de-energized and goes off. As long as SW1 is in the On position both relay A and B have no power, so the motor will stop. Pressing the foot switch again or keeping it pressed has no effect.

When the foot switch is released or the power returns nothing will happen until SW1 is returned to the Off position. Once SW1 is Off, we are back to the initial state and the machine can be re-started normally.

The scheme can easily be adapted for applications requiring both rotational directions of the motor by replacing SW 1 by a single pole, triple throw switch

(middle position Off) and adding a relay C wired as B with two phases exchanged (or the auxiliary phase capacitor of a single phase motor powered at the other end).

In normal operation the auxiliary relay A is permanently energized and should be rated for continuous operation. My workshop has a master switch for all machine equipment which is Off when I'm out so in my case this is no problem. I do want to mention here that if the foot switch is built into a metal case (as was mine) the case should be connected to protective ground for reasons of safety (as should be the motor and the machine body, of course).

Users of single phase equipment might be tempted to save relay B and connect the motor directly where the B coil is connected in the diagram, presuming that a1 and SW1 contacts are rated sufficiently. Of course this will work; but I suggest you consider that if the motor produces an electromotive force (EMF) while still running and the foot switch is released quickly (while the EMF of the motor is sufficient to re-excite relay A) the safety mechanism will fail. I would recommend to use relay B to be on the safe side.

This is a lengthy description of a simple circuit; completely unnecessary for those who use a relay in conjunction with momentary push button switches for the On and Off functions. However, there is a lot of machinery around which still uses latching switches that should or could be replaced; they may benefit from this idea. By the way, all components for this circuit were obtained from second hand markets at really cheap rates (car boot sales and scrap yards are also excellent sources).

The circuit as described here has worked for several months and gives me a much better feeling when I'm drilling sheet material or other critical stuff; my foot is positioned above the foot switch ready to interrupt at any time. By the way, I do not use this safety mechanism as an excuse to be careless!

There is one last word of warning which I would like to mention here: when wiring up this circuit never forget that you are dealing with mains voltage which can be anything but harmless; so be careful and observe safe working practices, or enlist the help of a knowledgeable friend.

Calling Scotland

Iain H. Tait of the Isle of Arran would like to make contact with other M.E.W. readers in Scotland. We will happily forward any letters to him.

I find that Scotland is not on your map for any news of clubs, or people. Perhaps a means of getting to know people locally could be started. For example, I would be interested to know of any other people, getting the magazines in my area!

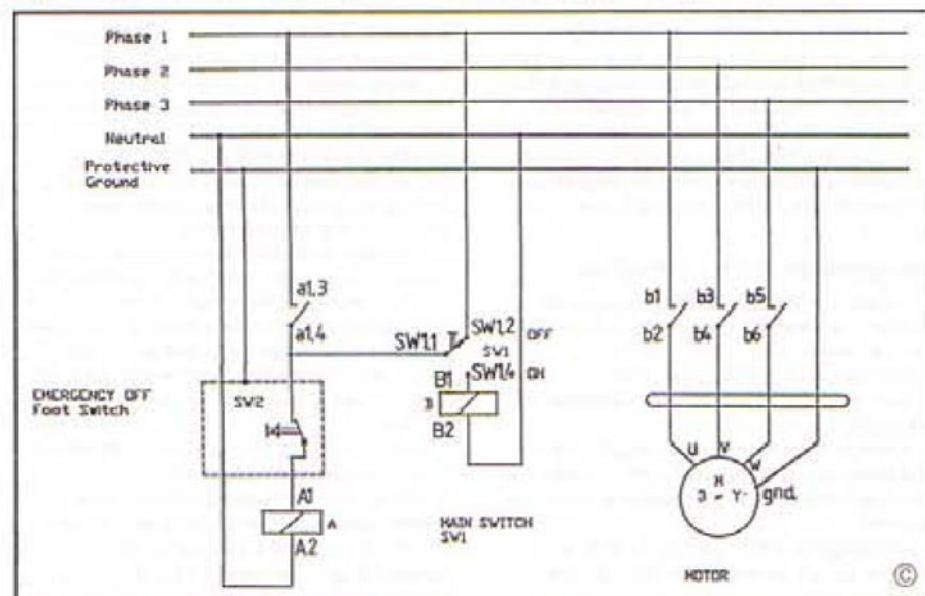
Safety hints

Ron Dyer of Boucherville, Canada sends us a couple of safety tips;

On safety may I mention two items:

1) Issue No. 18 page 10. Redthane belting. No mention is made of possible toxic fumes during heat splicing. The Eagle Belting Co. of Des Plaines, Illinois 60018 USA does give a mild admonition on their packaging.

I say mild advisedly, because when urethanes decompose on heating, there is a possibility of Hydrogen Cyanide being



evolved. The splicing job should either be done outside in a slight breeze, or indoors with the use of a laboratory type fume hood.

2) For eye protection, I use safety glasses, supplemented by a visor, which does not readily mist up.

Pyrometer pencils

Mr. R.F. Parsons of Cowley writes in reply to a readers Question, following a letter published in *Scribe a Line*, issue 18.

The Pyrometer Pencils I mentioned are tin plate cylinders containing what I can only describe as a 'Stick of Hookem' which you rub onto the thing whose temperature you want to know. When the object reaches the required temperature the 'Hookem' melts. The trade name of the Pyrometer Pencils I have is 'Thermomelt' these claim to have been made by Markal Company, 250N Washentaw Ave, Chicago, Ill. 60612, U.S.A. On the cases they state their accuracy as being + or - 1% of the stated temperature. The lowest I have is 92 deg.C and the highest is 950 deg.C. Where these came from originally I am not certain. The first few I found in a 25p per item box, in I think, either Sert Precision, (Farnham), or in a local tool sale run by an outfit called Tools & Things of Aylesbury. These gents run a monthly tool sale in the local church hall. The rest have 'turned up' from time to time in Autojumbles and such like places. Once you know what you are looking for they seem to appear with regular monotony. If you wanted to buy new ones, I would suggest you contact Markal, or their U.K. agents: Levermore and Co. Ltd. Tel. 081 946 9882. (I understand that individual pencils cost about £10.00 each - Ed.).

Twist drill geometry

Anthony Walton of Tulse Hill, London would like to know more regarding the geometry of the common twist drill.

Could some expert help me and all the bumbleheads like me to understand the theory of drill sharpening? Every available jig swings this-away and that-away and rarely any two of them about the same points. If only I could get it into my thick head what I was actually trying to do, perhaps I could devise my own jig.

Can somebody explain the solid geometry to the dull witted and demonstrate just what are the two cones one is trying to generate and precisely where their axes lie in space in relation to the axis and the point of the drill?

(A short article, soon to be published, on the subject of national and international standard quotes BS 328 as the standard for drills. Knowing that standards frequently detail the performance of a device rather than its precise design, can any reader explain the situation as far as drills are concerned? Ed.)

Welding safety

Roy Louthier, Managing Director of Wasp Welding and Safety Products c.c., Henley on Klip, South Africa writes about the hazards of welding, in particular, electrocution.

Mr. Slater, in the April/May 93 issue of M.E.W., refers to somebody being electrocuted in his place of work. This problem is nothing new. In most South African mines the fitting of an open circuit voltage reducing device on welders for underground use is mandatory, the Bureau

of Standards recommends that any welder with an open circuit voltage of more than 70 should be fitted with an open circuit reducing device.

The standard wiring regulations make it illegal to handle live circuits with bare hands above 50 volts; this regulation effectively makes most so called home welders illegal. According to the Mines and Works Act it is illegal for devices with voltages above 32 volts to be used in a vessel, on a mine or a rock shoot (which is the same as a vessel). The mining industry takes the danger of welding electrocutions very seriously indeed. However the same cannot be said for industry in general, who ignore the problem.

It must also be borne in mind that protection against open circuit voltages only does not protect against the problems that will arise during actual welding. Unless proper training is given to the welder operator, with particular reference to the problem of electrocution accidents will continue to occur.

I do not intend to go into detail as the whole subject is very involved and deals with such problems of the possibility of designing welders with lower open circuit voltage. It is generally not known that actual welding voltage varies between an arc extinction voltage of 18 volt DC and a maximum voltage on most applications of 32 volts DC whilst actually welding. High open circuit voltages are a function of the volt amp characteristic curve and power factor (AC welders). Arc promotion materials in the welding rod coating also play a part.

In regard to home welders it should be noted that the cost of our Weldsafe Unit would be about three times the actual cost of the home welder. Obviously our solutions are really only applicable to large 60 - 80% rated industrial welders. None the less the problems of open circuit voltages on home welders cannot be ignored, the use of gloves is essential to protect against burning, ultra violet light and to reduce the risk of electrocution.

Little John lathes and auto punches

Sometimes the number of replies received as a result of a reader request is large, in view of this Mr Jerrard of Exeter writes as follows.

In view of the large number of replies to my request for help regarding my Little John lathe, as published in *Scribe a Line* issue number 16, may I, through *Scribe a Line*, thank all those who replied, they were most helpful.

However my request for information on the workings of automatic centre punches brought no replies. Is there not one reader who can tell me how these work? I would very much appreciate any information that can be provided.

Reaming

Bob Loader replies to Hans Rudolf Brenner's comments on reaming in issue 18.

I'm sorry that Mr. Brenner finds it difficult to accept the 10% rule for Reaming, (*Scribe a Line*, Issue 18). He does raise some interesting points. It was not a misprint.

He is quite right to question a 10% allowance for hand reaming because the reamer will not, as he rightly says, enter a hole drilled 10% small. My somewhat

arrogant statement that, "the correct allowance to leave is 10% of the reamer diameter", could be re-phrased to read, "A 10% allowance always works for me", which it would perhaps be more accurate.

I only ream by hand when I have no other option and when I do, I give the reamer a start with a bigger drill than I have recommended, by drilling with the larger drill about two diameters deep. I stick to my allowance because it has always been my philosophy to give any cutter something to 'get hold of'.

When I was an apprentice, I did as I was told and left an allowance of $\frac{1}{16}$ in. for any reamer. I did so quite happily till I had to ream a 1in. hole. The $\frac{1}{16}$ in. smaller drill drilled big and the reamer fell through without touching the sides. Even a lowly apprentice, conditioned to do what he is told, will question dictates when they don't work; a similar experience with a much smaller reamer which couldn't take the $\frac{1}{16}$ in. and broke, made me question this dictum even more.

I chose 10% as a reasonable amount to leave and I have never had trouble with reaming since. The 45 deg. lead, on both hand and machine reamers normally takes care of the entry.

Using Mr. Brenner's figure of 2%, a $\frac{1}{16}$ in. reamer would need a 0.490in. drill, and a 12mm or 11.97mm drill. None of these sizes are standard, so there must be a compromise to begin with. In a perfect world drills would drill nominal size. Alas, they often don't and it is always bigger, never smaller.

Mr. Brenner follows expert opinion, quite rightly, and will not have any trouble until he uses the 1% allowance for a size of 25mm or larger, then there could be a problem.

I am one of those awkward people who don't always follow the book. I do what works for me. As long as we both get the results we want, and are doing nothing wrong, variations in the method aren't that important.

Drummond lathes

G. Holmes suggests a source of information for owners of earlier Drummond lathes, those having round belt drive.

In recent editions of your magazine there have been requests for manuals for early 3 $\frac{1}{2}$ in. Drummond lathes, the one with round belt drive.

As an owner of one of these lathes I was under the impression that literature was not available, this being gained from an article Drummond head stock bearings published in *Model Engineer*, 25 Jan 1962. However, this article, detailing the headstock and its bearing arrangement, could be of considerable interest to owners of this lathe.

I would also add that thanks to M.E.W. No.16, in the article The evolution of the lathe, Part 2, I recognized my other lathe, that had no nameplate, as an Atlas. Consequently, I have been able to purchase spare parts from the advertiser in *Model Engineer*.

(Copies of the article previously published and mentioned above, can be obtained, price £1.50 to U.K. readers, and £2.00 overseas. Requests should be sent to Photostat Service, Argus Specialist Publications, Boundary Way, Hemel Hempstead, Herts HP2 7ST.)



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